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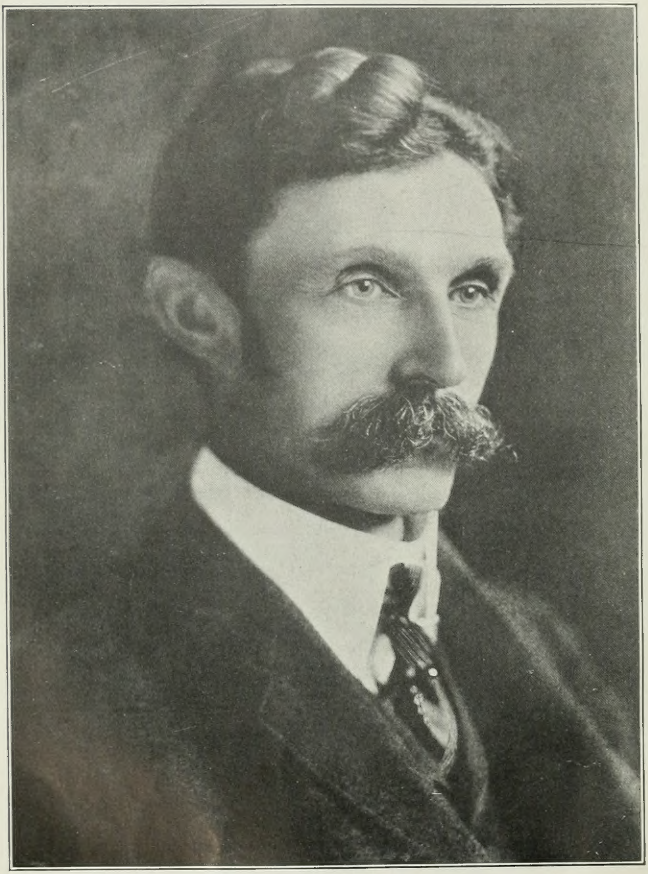

JOSEPH AUSTIN HOLMES.

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MEMORIAL SKETCH OF DR. JOSEPH AUSTIN HOLMES*

By Joseph Hyde Pratt

The life of Dr. Joseph Austin Holmes was devoted to the development and welfare of his country, and in his death the people of the United States have lost one of their most efficient and valuable public servants. He was a man who put duty first, and in carrying out this ideal he gave his life in an endeavor to improve the condition and safety of the miners. He did not know the word "failure"; and, where other men would have failed, he has been able to accomplish the results desired. It is granted to but few men to be able in the few years of their life's activity to do that which will leave a permanent influence and impress upon an industry; but to Dr. Holmes, whose life we are now commemorating, this distinction was allotted.

Due almost entirely to his energy and efforts, there has been created throughout this country an organized movement looking to the preservation of human life; and, although his first work was directed toward the prevention of mine accidents, and to the safety and welfare of the hundreds of thousands of men who daily risk their lives in the production of fuel so necessary to the Nation's industry and commerce, it developed the "safety first" idea that has spread to nearly every industry and into all walks of life. These words are almost synonymous with the word "Holmes," and wherever we see "safety first" we are reminded of the wonderful achievements of this man. He has not only left his impress upon an industry, but has also created an organization which will live as long as our Government exists and is a monument to the tireless energy, public-spiritedness and unselfishness of the man who is responsible for its creation. I refer to the

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* Read at the annual meeting of the Geological Society of America, Washington, D. C., December 28, 1915.

Bureau of Mines, whose foundation he laid by many feats of exacting labor and fruitful work, and who, by masterful generalship and arguments, as he only could use, carried the bill to establish the Bureau of Mines successfully through an unsympathetic Congress.

To Dr. Charles D. Walcott, former Director of the United States Geological Survey and now Secretary of the Smithsonian Institution, must be given the credit of recognizing those qualities of character and ability in Mr. Holmes which he realized were necessary in a man who could not only lay the foundation and build up an organization that would lead to a Bureau of Mines, but who would also be able to direct it after its creation. In a recent communication from Dr. Walcott, he wrote:

"About 1900 it became more and more evident that he (Dr. Holmes) was a man of broad conceptions and fitted to undertake work of national scope, and it was with great pleasure that I learned in 1904 that he was willing to give all of his time and energy to the development of the Section of Mines and Mining in the Federal Survey. I told him that as soon as the work was sufficiently well organized it would be made a Division of the Survey and undoubtedly lead to the creation of a Bureau of Mines and Mining. He entered into the work with a zeal and intelligence that was not fully understood by his immediate associates, but the work steadily grew, and in 1910 he was appointed Director of the Bureau of Mines."

His appointment, however, was not attained without very severe opposition from a Secretary who was hostile to Dr. Holmes, and it is rumored that this important position was offered to several other men; but, to the credit of the men of science of this country, it can be said that they all refused to accept what all knew rightfully belonged to another. Those who knew Dr. Holmes, having confidence in his ability and believing that he was the logical head for the new bureau, were persistent in their demand that he should receive the appointment. It is not generally known how near the bureau came to losing Dr. Holmes as its director, and how near the University of West Virginia came to securing him as its president; and, as an incident bearing on this is illustrative of the loyalty of Dr. Holmes' friends, I wish to quote in part a few lines from a letter I recently received from Dr. I. C. White, State Geologist of West Virginia:

"It was during this discouraging period of his life, just before the appointment of a Director of the Bureau of Mines, when he had given up all hope of

receiving the appointment, that he came up from Pittsburg to spend the week-end at the writer's home in Morgantown, W. Va. He was weary and care-worn from the long and disappointing vigil, but gentle and loving as ever. No word of reproach or bitterness escaped his lips. If he could not serve his country in an edifice his own hands had so largely constructed, he was ready to give his services to a State that had stood by him in his long battle, and where he knew he would be among appreciative friends. The State University of West Virginia was seeking a president, and one of the purposes of Dr. Holmes' visit to my home was to acquaint the writer, who had ever been his trusted friend, with the fact that he had despaired of being appointed Director of the United States Bureau of Mines, and would accept the presidency of the University of West Virginia if the Regents of the same would make the tender."

Fortunately for the industry, Dr. White and others, realizing that for the success of the Bureau of Mines it was necessary that Dr. Holmes should be its head, decided out of genuine loyalty to him and appreciation of his work, that they would not place his name for action before the Regents of the University until President Taft had actually bestowed the Directorship of the Bureau of Mines upon some one else. His friends' belief in what President Taft would finally do was confirmed a few days later when the appointment of Dr. Holmes was announced from the White House.

That he was a wise selection is evidenced by the wonderful development of the Bureau under his administration. The work he had planned as Chief of the Technologic Branch of the U. S. Geological Survey developed rapidly, aided by Congress, which widened the scope and enlarged the purposes of the bureau. The principal investigations taken up under Dr. Holmes' directorship and the results accomplished are as follows:

An investigation in regard to the improper use of explosives and the use of improper explosives.

Investigation in regard to better lights for mines. Result, the establishment of a permissible list of portable electric lamps for use in dangerous mines.

In developing rescue work, Dr. Holmes introduced into this country the so-called "oxygen breathing apparatus." Result, such apparatus is now not only widely used in mine-rescue work, but is being adopted by manufacturing plants and by city fire departments. There are today six mine-rescue stations, eight mine-rescue cars, and one rescue

motor truck operated by the Bureau of Mines. There are seventy-six mine-rescue stations that have been established by mining companies, at which there are 1,200 sets of artificial breathing apparatus in addition to the auxiliary equipment for first-aid and fire-fighting work. There are also twelve mine-rescue cars being operated by mining companies.

Investigations into the causes of disasters and the recommendations made by the Bureau have resulted in an ever-decreasing death rate.

The investigation of coal dust and explosions therefrom was one of the most important lines of investigation that Dr. Holmes took up. The result today is that the entire mining industry, including operators and miners, is convinced that coal dust will explode, and recognize the danger from it; and mine operators and State officials are following the recommendations of the Bureau to prevent dust explosions.

Investigations have been conducted regarding smelter smoke wastes and wastes in the treatment of rare minerals and metals. Dr. Holmes emphasized the need of such investigations, indicating that there was at least $1,000,000 a day being wasted or lost by the present methods of mining and utilization of our mineral resources.

Investigations regarding the extraction of radium from its ores have resulted in the development of a process through which it will be possible to greatly reduce the cost of radium compounds to the consumer. "The process is to be patented and dedicated to the public."*

Investigations have been started to reduce the great loss of $75,-000,000 annually, due to coking coal in beehive ovens. As a result already some of this loss has been reduced through the use of by-product ovens and the utilization of the by-products obtained.

Dr. Holmes called attention to the annual waste of over $4,500,000 in brass furnace practice and then had prepared a report showing how, by practicable means, this waste can be largely prevented.

These are some of the investigations Dr. Holmes had the Bureau of Mines take up, and they illustrate the wide scope of the work he was planning for the Bureau to undertake. Its development into one of the most important of all the Federal bureaus has been phenomenal and is due not only to the indefatigable work of the Direc-

*Van H. Manning, Jour. Ind. and Eng. Chem., Vol. 7, No. 8, page 716, Aug., 1915.

tor, but to the fact that he was a splendid judge of men and their capacity for work, and was able to surround himself with the type of men who were able to carry out the plans his master-mind had conceived; and these men were loyal and true to him.

He was thoughtful and considerate of his associates; and while he may have demanded much of them, he always gave them full credit for work done; and of the reports of the investigations carried out by the Bureau but very few bear his name as author. Credit is given to him who carried on the investigation. Dr. Holmes planned the character of the investigation, then put it up to one of his associates to do the detail work. What he wanted was results. He had little time to write for publication or to think about personal advancement, and he left it to his associates to do the writing and give him the results—and results he surely obtained.

Although Dr. Holmes was the author of but comparatively few publications, yet he was personally responsible for the publication of many important scientific and economic papers, because he had the foresight to open up new fields of investigation and secure properly trained men to carry on the work he outlined. I doubt if there has ever been a man who surpassed him in this respect.

This faculty of Dr. Holmes' showed itself soon after he became State Geologist of North Carolina in 1891. In this position he had wide latitude for planning a varied line of investigations relating to many subjects, inasmuch as the object of the State Survey was the investigation of all natural resources of the State. Almost as soon as he was appointed State Geologist he began to plan new lines of work and to call in to assist him men who were fully qualified to carry on the investigation he desired. Thus you find associated with him during the first years of his directorship of the State Survey such men as Professor George Williams of Johns Hopkins, Professor S. L. Penfield of Yale, Dr. George F. Kunz of New York, Professor F. P. Venable of the University of North Carolina, Dr. George P. Merrill of the National Museum at Washington, Professor George Swain of the Massachusetts School of Technology, Professor Thomas L. Watson of the University of Virginia, Professor H. V. Wilson of the University of North Carolina, Professor William Cain of the University of North

Carolina, Mr. H. B. C. Nitze, Mr. Gifford Pinchot of Washington, Professor Heinrich Ries of Cornell, and others. The published reports of the State Survey, similarly as those of the Bureau of Mines, seldom bear the name of Holmes as one of the authors.

Dr. Holmes did a great deal to broaden the scope of the State Geological Surveys, and to demonstrate that there could be and should be a close coöperation between the State and Federal Surveys. There was always most friendly coöperation between the North Carolina Survey and the Federal Survey; and, although the State received very largely from the Federal Survey, it gave very largely in return, for Dr. Holmes was always ready to give his time and energy to any work which promised to be of service to the Federal Survey; and he was often called in consultation regarding the work of that Survey. Dr. Walcott, who was then Director, states that he was early impressed with Dr. Holmes' thoroughness and the quality of his work as State Geologist. In the Geological Survey his most important work was probably the application of geology to the industrial development of the country. He started this in the State Survey, but later introduced it into the Federal Survey.

As State Geologist he became very much interested in the preservation of the forests of the Southern Appalachian region, and it is due largely to his work as State Geologist that the Weeks bill was passed by Congress, which has resulted in the purchase of forest areas to be used for forest reservations in the Southern Appalachian region and the White Mountain region. It was under the supervision of Dr. Holmes that the mass of evidence was collected which proved to the congressional committees that it was absolutely necessary for Congress to take some action to prevent the destruction of the forests of these two areas in order to protect the flow of navigable streams.

In connection with an investigation relating to our turpentine industry, he had experimental work carried on in regard to the cup and gutter method, which is now in general use in this industry. He also had investigations made as to the practicability of the reproduction of the long-leaf pine, and an actual demonstration in planting of seed proved the feasibility of such reproduction.

Dr. Holmes also started the "good roads" movement in North Carolina, and one of the first publications of the State Survey was a report on "Road Materials and Road Construction in North Carolina." While his work in connection with the roads was almost entirely from the educational standpoint, yet it was this work that made it possible for his successor to obtain through the North Carolina General Assembly the creation of, first, a Highway Division of the Survey and, later, a State Highway Commission.

In the State work Dr. Holmes also began investigations in relation to the waterpowers, mineral waters, underground water supplies, timber resources, mineral resources and fisheries of the State; but a limited treasury and lack of time prevented him from carrying these out as rapidly as he desired, and it was left to his successor to complete some of them.

During his term of office as State Geologist, 1891 to 1905, the Survey published twenty Bulletins and Economic Papers, giving the results of investigations that he had started. In 1905 the act creating the Survey was repealed and a new act, which was prepared by Dr. Holmes, was passed by the General Assembly. This created the North Carolina Geological and Economic Survey.

Dr. Holmes brought geology to this people and made them realize its value and application in the arts.

In connection with the investigation of the Fisheries of the State, Dr. Holmes was the leading spirit in the establishment of the Biological Laboratory at Beaufort. In June, 1897, after consultation with Dr. Holmes and Professor H. V. Wilson of the University of North Carolina, the United States Commissioner of Fisheries established at Beaufort, North Carolina, a temporary station for the investigation of the marine fauna and flora of the Southern coast. Professor Wilson was appointed director, and for the next three years he and Dr. Holmes devoted much time and thought to its development. Congress finally made an appropriation for the establishment of a permanent laboratory, but made no appropriation for the purchase of a site. Dr. Holmes recommended a site and arranged for its private purchase and its donation to the Government. He, with Professor Wilson, drew up the outline plans for the laboratory buildings and he remained in

close touch with the work of the laboratory until his resignation as State Geologist. This work of Dr. Holmes had an important bearing on the Fisheries of the State of North Carolina, as it started the interest of the people of the State in the value of the fisheries and finally resulted, some years after the resignation of Dr. Holmes as State Geologist, in the creation of the Fisheries Commission of the State of North Carolina.

Dr. Holmes' work as State Geologist brought him prominently before the public, and in 1903 he was chosen Director of the Department of Mines and Metallurgy at the St. Louis World's Fair. He accepted this appointment and had charge of and organized that department. He planned the exhibits and introduced new features for the exhibits which have since been adopted by all succeeding expositions. These new features made the Mines Building of the St. Louis Exposition the most successful and instructive Mining Exhibit that was ever made at any exposition. For special services rendered at this exposition he was decorated by several foreign governments. In connection with the Mining Exhibit he suggested that an investigation be made of the fuels of the United States and was successful in persuading Congress to authorize the investigation and make the necessary appropriation with which to carry on the work. Dr. Holmes and, at his suggestion, two representatives of the U. S. Geological Survey were created a committee to carry on the investigations which were made during the years 1904 and 1905. Although Director of the Department of Mines at St. Louis, Dr. Holmes continued to have general supervision of the work of the North Carolina Geological Survey. Early in 1905 the Director of the U. S. Geological Survey appointed Dr. Holmes to take individual charge of the Fuel Investigations, and soon after he was appointed Chief of the Division of Technology of the Federal Survey, and then severed his connection with the State Geological Survey.

While connected with the Federal Survey, Dr. Holmes examined Mine Experiment Stations and Mine-rescue Stations in Great Britain, Belgium, France, and Germany, and it was the result of these studies that led to the inauguration of the movement for mine-rescue work in this country.

In 1907 President Roosevelt, on Dr. Holmes' recommendation, secured the appointment by the governments of Great Britain, Germany, and Belgium of one expert engineer from each of these countries to visit the United States and then visit with Dr. Holmes the more important coal fields of this country. This was done in order to determine to what extent the safety practices used in other mining countries might be introduced into the United States. It was on the basis of the findings of these engineers that Dr. Holmes developed and organized his investigations relating to mine explosions, etc.

In 1908, when President Roosevelt took up the question of the conservation of our natural resources, Dr. Holmes was appointed a member of the National Conservation Commission, and he had charge of the inventory of the Nation's mineral resources.

In all Dr. Holmes' work his central thought had always been the development of the mining industry and the improvement of conditions affecting the miner. In carrying out this great purpose he thought only of the object to be attained and paid little or no heed to personal attacks or opposition such as inevitably accompanies a forward movement or investigation that requires the coöperation of both the legislative and administrative departments of our Government. When, however, an attack was made on him that appeared to endanger the work itself in which he was engaged, he was then ready to put forth all his efforts to meet and defeat the opposition.

Dr. Holmes was human, as the rest of us, and occasionally was forgetful in regard to certain things that were to be done. This characteristic of his sometimes led to severe criticism of his work by those who were not thoroughly acquainted with him. Whenever any apparent neglect on his part was called to his attention the matter was instantly taken care of and ample apology made for the oversight. Dr. Holmes was excessively careful to observe all the little courtesies of life and was a splendid representative of the Southern Christian gentleman.

Dr. Holmes was born at Laurens, S. C., November 23, 1859, and died at Denver, Col., July, 1915, after nearly a year's illness and fight against tuberculosis. His illness was undoubtedly brought on by severe exposure in connection with the examination of mines for ex-

plosions and of hardships endured in investigations regarding mining conditions in Alaska. His parents were Z. L. and Catherine (Nickles) Holmes.

His early education was in the schools of South Carolina, but his university work was at Cornell, where he graduated in 1881, taking the degree of B.S. Later he received the degree of D.Sc. from the University of Pittsburg, and in 1909 the degree of LL.D. from the University of North Carolina. During his college course Dr. Holmes devoted especial attention to chemistry (including the chemistry of explosives), to metallurgy, geology, general physics, and mining. He visited mining regions and metallurgical plants in many parts of the United States, Germany, France, Great Britain, and Belgium.

In the fall of 1881 he became Professor of Geology and Natural History in the University of North Carolina, and held this position until 1891, when he became State Geologist.

On October 20, 1887, Dr. Holmes married Miss Jeannie I. Sprunt, of Wilmington, N. C.

Dr. Holmes was a fellow and charter member of the Geological Society of America, fellow of the American Association for the Advancement of Science; member of the American Institute of Mining Engineers, American Society for Testing Materials, and American Society of Mechanical Engineers; he was appointed a member of the Mining Legislation Committee of Illinois; one of the founders of the Elisha Mitchell Scientific Society; member of the Sigma Xi Scientific Society; member of the Washington Academy of Science, St. Louis Academy of Science and the North Carolina Academy of Science; member of the Cosmos Club of Washington, and the Engineers' Club of New York.

In closing this sketch, let me further express my feelings and thought regarding Dr. Holmes in the words of several friends who were very close to him:

"Dr. Holmes stands as one of the finest examples of unselfish devotion to the cause which he championed, even to the extent of giving his life for it. Mining in America in its national aspect is more deeply indebted to him on its scientific, operating and industrial sides than to any one other individual. It seems most unfortunate that Dr. Holmes did not live to aid the movement to improve the laws affecting mines and mining; but, with the Bureau of

Mines firmly established, and coöperating with the thoughtful mining engineers and operators throughout the country, the results he hoped to see should be speedily obtained."—*Charles D. Walcott.*

"Ever thoughtful, resourceful, a great organizer, a clear, logical and eloquent speaker, a splendid judge of men and their capacity to do the work his master-mind had planned, the U. S. Bureau of Mines, founded only in 1910, has, under his leadership, rapidly grown to be one of the most important of all Government agencies. * * * His monument is the U. S. Bureau of Mines, and his memory will be cherished forever in the hearts of countless miners whose lives he has rendered safer in the perilous occupation they follow, and without the product of whose busy hands our present civilization could not exist. Although cut down in but little beyond the prime of life, he has left us an example of what glorious achievements indomitable will and untiring work can accomplish. The great Bureau he so largely created and so successfully directed will continue its brilliant work along the path he so skillfully blazed, since, thanks to a very able and conscientious Secretary of the Interior, his successor is in thorough accord with the high ideals of the former Chief, and was ever his efficient helper."—*I. C. White.*

"In the death of Dr. Holmes the people of the United States lose one of their most remarkable and efficient public servants. And the saddest part of it all is that Dr. Holmes is a victim of overwork, a too great devotion to the duties which had been assigned to him in behalf of the safety of the million miners in the United States. He was one of the most enthusiastic, indefatigable workers I ever had the pleasure of associating with. His mind was continually upon the yearly death toll of the miners, and although taken away in the prime of his life, he has already accomplished much in reducing the terrible death rate. In the last five years of his life he saw a slowly but steadily decreasing death rate, and while it gave him much joy, it only added to his almost superhuman efforts in behalf of the men."—*Van H. Manning.*

A full list of Dr. Holmes' reports and more important scientific papers is given in his Bibliography appended to this sketch.

CHAPEL HILL, N. C.

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JOSEPH AUSTIN HOLMES

By F. P. Venable

It is with some shrinking that I undertake this sketch of him who for thirty-five years was one of my closest, most intimate friends. It is not easy to lay bare the thoughts or feelings of such a friendship or to dissect and analyze the work and character of one who was so near and who shared the joys and trials, the hopes and disappointments of almost a lifetime. I shall attempt little of such analysis, and content myself, in the main, with a brief outline of the life as it touched my own.

Joseph Austin Holmes entered the service of the University in 1881, a few months after graduation from Cornell; very much as I had been summoned a year before, differing somewhat, though, as my work at Bonn was incomplete, and I had to go back in the summer of 1881 to get my degree.

We were both just boys, he a year or two the younger, full of enthusiasm and energy for the big work which we realized was before us, and yet we were sadly hampered by the lack of almost everything in the way of books and equipment to which we had been accustomed. For the University of that day was struggling to rise from the desolating effect of Reconstruction Times, received no support from the State which it had so faithfully served in former years, and, with little money and only a few devoted friends, had to meet bitter opposition and misunderstanding on every side.

I never knew a more buoyant, optimistic nature nor a more determined spirit than that of this young Cornell graduate, scarcely twenty-two years old. He gathered his groups of students about him and took them to the fields, the forests, and the rocks as his laboratories. He won their respect and affection and inspired many with his own love of nature and enthusiasm for science. There was no University library in those days, or, at least, the books gathered in a preceding age were kept practically locked up. So we spent our own small savings in gathering a few books around [illegible] providing any special apparatus.

Holmes and I kept bachelor's quarters in one of the University residences, he choosing the upper story and I the lower. The arrangement had its inconveniences, since his passion for collecting made him gather a miscellaneous assemblage of insects and reptiles, some of which had an uncanny habit of wandering down the stairs in the night to visit my quarters. I had a notion that the visits would have been less tempting and made with less facility if I had chosen the upper floor. But no one could stay provoked with "Old Holmes," as nearly every one called this beardless boy, and the term was one of affection, for a gentler, sweeter nature was hard to find. Besides, one was disarmed from the beginning, for he himself was never provoked, but always unruffled and smiling—and in his later years I have seen him under terrible stress, without losing his composure and grave smile, when the hot blood surged in my veins in his behalf.

Two years after he began his work here we talked over the situation and came to the conclusion that for our own salvation, if for no higher reason, we must gather some kindred souls about us, and by the elbow-touch ward off the deadening effect that isolation was bound to have upon our scientific work.

On September 24, 1883, we invited Professors Gore and Graves of the University faculty, and an enthusiastic young alumnus, Dr. Wm. B. Phillips, now President of the Colorado School of Mines, to our house and discussed the formation of a society for the encouragement of scientific work. The idea was taken up with enthusiasm, and we decided to name it the Elisha Mitchell Scientific Society, after the most prominent of the earlier professors of science in the University. At first its membership was to be state-wide and its roll of members was made up of some hundred or so friends, doubtless interested in watching this group of young professors, and wondering what they could accomplish against the general apathy and indifference. Their interest lagged after a year or so and outside support dropped off, but the idea was too big to die, and the society, maintained by a few devoted souls, grew in the importance of its work, the number of its contributions and in reputation among the scientific societies of the world, and has now an honorable history of a third of a century of achievement behind it. It would be difficult to estimate all that the

existence of this society has meant to the University and the influence it has exerted upon its development. During the time of his connection with the University Holmes made many contributions to the pages of its journal.

One of Holmes' most striking characteristics was his indomitable energy and will-power. He was tireless in his work and, though not a physically strong man, could easily tire out other men in a geological excursion, mountain-climbing, or the attainment of any other goal upon which he had set his heart. He simply never acknowledged that he was worn out. He also had a marvelous faculty for convincing others that they were not so tired as they thought they were.

I never met any one with such power of leading others to do what he wished them to do, whether it was a body of students, a convention, or a legislative assembly. His grasp of details, wide knowledge, quite unruffled, nonruffling, convincing way, and his utter unselfishness, had much to do with his wonderful success in such matters. He did not antagonize, yet he never abandoned his point. Apparent defeat he quickly turned into victory, and a victory without bitterness. He simply had a fashion of putting his spectacles over your eyes, so that what you had seen as a vivid, disagreeable blue was really rose-tinted, as he had said it was, and withal very pleasant to the eyes.

When he was trying to convince certain indifferent or reluctant State legislatures that the Appalachian Park Reservation was a good thing, the Governor of one State emphatically declared that he should never appeal to or appear before his legislature. And yet he did appear, and, I understand, was introduced by the Governor, and the legislature passed his bill.

Once in our own legislature a determined effort was made to withdraw the appropriation for the State Geological Survey. At his request I had done all that I could to stem the tide, but without avail. I felt that the Survey was doomed, and told him so. He made no comment, but went to see the committee which had charge of the bill and which was almost unanimously against the continuance of the Survey. After two or three hours he came back to the hotel where I was. "Well! have they smashed the Survey, Old Man?" I asked. "Oh, no," he said, without any indication of triumph or excitement. "They have concluded to double our income."

He went to Germany, presumably on a sort of vacation, for he was quite worn out, but turned it into a general investigating tour of the geology, mining and certain manufactures of the country. I saw later, in a New York paper, that he had obtained from the Government officials more concessions and was granted more privileges than had ever been granted to an American man of science. I know that later he was decorated with a German order, as he was by Japan and other foreign governments, for services rendered. I have no doubt the Germans thought they were really glad to give up their secrets, whatever they may have thought of it before he came.

His active services for the University were comprised in an all too brief ten years. He clung, however, to a nominal connection with the faculty, retaining his name on the roll as a member of that body. Always in his heart there was a deep, abiding affection for the University and a most active interest in its welfare. He had been a sharer in its earlier struggles and in many ways he continued to help in its advancement.

He left the State to enter Government service; first in connection with the U. S. Geological Survey and then as Director of the Bureau of Mines, which his foresight and energy had built up. The services which he rendered to the Nation have been described by another.

In every relation he showed the same singleness of purpose, unselfishness of character, genius for leading, and loyalty to his friends. He felt deeply the call of humanity and served with an untiring zeal until, worn out, he fell asleep, finding at last the rest he had so often denied himself. Truly, he died for others.

Our loss is great, but the memory of this rare and noble spirit cannot be taken away from us.

DR. JOSEPH AUSTIN HOLMES AT THE UNIVERSITY OF NORTH CAROLINA

By Kemp P. Battle

This sketch is intended only to give a glimpse of Professor Holmes while in the University of North Carolina.

For years after the revival of the University its income was only about $15,000 per annum, then increased to $20,000. In those days of penury our professors were forced to attempt tasks too burdensome for human shoulders. We needed a teacher in the vast domain of Geology and Natural History. The hearty commendation by the authorities of Cornell University of a youth, twenty-one years of age, with the degree of Bachelor of Agriculture, Joseph Austin Holmes, caused the Trustees, on the nomination of President and Faculty, to elect him unanimously.

His father was a Presbyterian clergyman of New York State, who had removed to South Carolina as pastor of a flock and owner of a farm. The son was trained in the faith of his father and was a church member. He had the inestimable advantage of sound bodily health and strength, gained by vigorous exercise, farm labor, and as an expert in "breaking" horses and mules. He possessed uncommon activity, endurance, and a happy, kindly, buoyant temperament.

He entered on the duties of his professorship with cheerful pluck. The slender income of the University threw on him instruction in Geology, Mineralogy, Zoölogy, Physiology and Hygiene, and Botany. For several years, with exceedingly inefficient equipment, he struggled manfully under this grievous burden. Then an assistant was allowed him, the very able Professor Atkinson, now of Cornell. In the division he retained Geology, Mineralogy, and Botany.

In 1893 he accepted the office of State Geologist, but continued on the staff of the University as Lecturer on the Geology of North Carolina, until 1906. That his University duties were satisfactorily performed was testified to by a large and able committee of the Trustees, of which a prominent teacher and Senator from Chatham, A. Haywood Merritt, was chairman, and Judge Charles M. Cooke, General

Julian S. Carr, and Messrs. J. P. McEachern, Paul B. Means, B. F. Grady, and Rev. A. D. Betts were members, whose report to the Trustees was transmitted to the General Assembly and published. They said of his department: "He presides over it with the vigor of youth and with the skill and learning of age."

In addition to the enormous work of his department, his abounding energy and willingness to work for himself and others led to vacation excursions through many counties, often accompanied by students, to the improvement of roads around Chapel Hill, to the duties of town commissioner. Indeed, he was sometimes induced to undertake tasks which required his presence at different places simultaneously. A story floats around the village that he invited Professor Gore to dinner, forgetting to mention the fact to his wife, and likewise being himself absent from his festive board.

He was quick in the adoption of expedients to remedy an inconvenience. Once when I was on my way to the railway station in a village vehicle, called a hack, I called at his home to take up himself, wife, children, and their baggage. When the driver called "Time's up," he packed in all but himself, and I was wondering whether he would stand on the tongue of the vehicle. With no sign of haste he said, "Go on, driver; I'll overtake you." Off he went to his stable, saddled and bridled his horse, pursued us in swift gallop, and we were on the train just as the bell cord was pulled.

At a Commencement when the village was unusually full of guests he was requested to see to their comfort. His hospitality had filled his own house and the last night he was unable to get a moment of sleep. Notwithstanding this, he started with a company of students to take the train at Merry Oaks, twenty miles distant. After a few minutes ride he said, "Boys, I am sleepy. I will have to walk." He alighted and kept up with the carriage eighteen miles without sign of exhaustion.

He was, to all appearances, inaccessible to fear. When journeying through Oregon and the State of Washington with a company conducted by a guide through an extensive forest, he took a fancy to leave the escort and the road and walk to their destination alone through the unknown woods. Unmindful of the danger of losing his

way, or being attacked by bears or savage men, he found pleasure in his lonely tramp under the stately trees.

He was a pioneer in the good roads movement. To him we owe the pleasant, winding descent from Chapel Hill, about a mile towards Durham to Bowlin's creek, probably the first improved highway in Orange County. With his tireless energy he was urging other road betterments when he was called away to more important duties, to the great regret of the community, whom he loved so well and who loved him.

When, just of age, he reached Chapel Hill, he probably had never seen a person in its limits. Although he had no trace of undue forwardness of manner, such was his bonhomie and freedom from bashfulness that in a very short time "Joe Holmes" was welcomed in all our families.

The early years after his arrival he spent in the household of Rev. Dr. Charles Phillips, and to him and his wife Laura he was like unto a son. Their affection was mutual.

There never was a man more charitable in word and deed. His generosity to the needy was only limited by his bank account. He never attributed bad motives to others, and he was lenient to offenders as long as there was hope of reform. His generosity to the University was to the extent of his means. His name is among the subscribers to the History chair to a handsome amount, and he was one of the stockholders of our first gymnasium, which when erected was of essential value to the University.

Although devoted to his church, he was totally without harsh thoughts of other denominations of Christians. Bigotry was no part of his sunny temper and sound sense. He was active in church affairs, an elder and a deacon. He and his warm friend, Dr. F. P. Venable, were prime movers in the purchase of a commodious manse in a pleasant neighborhood. Out of his meagre salary he paid about one-fifth of the purchase money.

He was active in the formation of the Elisha Mitchell Scientific Society, and was its first vice-president. In the early years of its valuable life he contributed to its columns fifteen papers on scientific subjects. He was a teacher in some of the Summer (or Normal)

schools of the University and delivered interesting and able lectures in others.

His wife, sister of one of North Carolina's best citizens, Mr. James Sprunt of Wilmington, was a worthy daughter of the able and beloved servant of God, who as teacher of youth and minister of the Gospel, was a shining light in our southeastern counties, Rev. Dr. James M. Sprunt. Her excellent, tactful sense and devotion to all duties relieved her busy husband of household cares, so that his full time could be devoted to acquisition of knowledge and to his labors for science and his community.

He once proved his love for the University and for Chapel Hill by securing a lot and erecting a commodious dwelling thereon. He was a model husband and father. His pleasant ways made all around him happy, and his sanguine temper and high principles descended to his children.

In conclusion, I say that we never had a more useful and lovable citizen. All grieved that he left us, but he had our heartiest rejoicing over his upward career. There was grief in our community over his premature death. We mourned over the loss of one whom we loved and who loved us.

ON LEIDY'S OURAMŒBA AND ITS OCCURRENCE AT GREENSBORO, N. C.

By E. W. Gudger

Owing to its extreme rarity (the present writer had previously seen but one specimen) it seems to be worthy of record that during the fall of 1914 I met with considerable numbers of this interesting protozoan. These were large forms which from their easy mobility and very blunt pseudopods would have been designated as *Amœba proteus* but for the very considerable number of fungous filaments protruding from their posterior ends. These filaments stood out in a mass, not in separate tufts as Leidy's figures mainly show, and in some cases were as many as 25, that many having been counted in one large specimen—probably there were more. The free portions of these mycelial threads varied in length; some were as long as the longest diameter of the amœbas, while others were only half as long as their hosts.

The amœbas seemed in no wise incommoded by these tail-feather-like appendages, but moved freely, changing direction at will and having no trouble in ingesting diatoms with which their bodies were so gorged that neither nuclei, contractile vacuoles, nor the spores from which the mycelia arose could be seen. While the amœbas moved freely and changed direction often, there was no reversal of polarity; the part in which the filaments were always remained posterior. The movement in a new direction never took place at an angle much if any greater than 90° from that of the previous motion, the "tail" being gradually switched around.

These amœbas, to the number of two dozen or more, were observed from time to time in the course of class work, in fact, for more than two weeks hardly a laboratory period passed without one or more being found. But owing to great press of other work no attempt was made to ascertain their numbers in the material which was brought in in small wide-mouthed bottles and set in the full sunlight of the eastern windows of the laboratory.

However, all this material came from one place—a small swampy pool made by a little brook debouching on a flat at the foot of a hill.

Above this point the stream flows in a little valley on the sides of which are a considerable number of houses whose gardens and back lots extend down to its banks. Where it first emerged on the flat the stream widened out into a small clear pool, the lower shallow end of which had its bottom covered with diatoms. A little further down the flow of the water was obstructed by a fairly thick growth of weeds and grass, around and between which diatoms, desmids, and a species of *Oscillaria* covered the bottom with a brownish felt. So thick was this that in many cases the gas given off would float this felted mass to the surface of the water, where it could be skimmed off with a spoon or sucked up with a wide-mouthed pipette for transfer to the bottles referred to. This material fairly swarmed with amœbas, *proteus* being the most common form, sometimes 25 being counted in one field under the 16 mm. objective. In this material the Ouramœbas were found.*

It is interesting to note that this is not the first record of the occurrence of this extraordinary rhizopod in North Carolina. Dr. W. L. Poteat of Wake Forest College found specimens at Wake Forest in February and March only of the years 1894, 1895, and 1896. In the first of these years he found but one, a notice of which he published in *Nature* for May 24, 1894. While in *Science,* under date of December 2, 1898, he published a more extended and exceedingly interesting account with figures.† His specimens, it may be noted, came from a small stream where, a few yards out from the spring in which it originated, it was obstructed by water plants and where there was a good growth of *Oscillaria.*

Furthermore, the above record is not that of the first occurrence of *Ouramœba* in America. That great naturalist, Joseph Leidy, first found it near Philadelphia in May, 1874, and on the 12th of that month he gave an oral description of it before the Philadelphia Academy of Natural Sciences. Since Leidy's original description of this interesting rhizopod is not well known, it may be well to reproduce it here.

*A recent visit to this collecting ground showed that all had been changed; heavy rains had brought down such quantities of sand that pool and swamp had both been filled.

†I wish here to acknowledge my indebtedness to Dr. Poteat, whose later paper (1898) contains references to practically all the known literature. Examination of Doflein's Protozoa shows that nothing seems to have been added of late years.

"Prof. Leidy remarked that * * * he had discovered what he suspected to be a new generic form [of *Amœba*]. It has all the essential characters of *Amœba*, but in addition is provided with tufts of tail-like appendages or rays, from which he proposed to name the genus OURAMŒBA.

"The rays project from what may be regarded as the back part of the body, as the animal always moves or progresses in advance of the position of those appendages. The rays are quite different from pseudopods, or the delicate rays of the *Actinophryens*. They are not used in securing food, nor is their function obvious. The *Ouramœba* moves like an ordinary *Amœba*, and obtains its food in the same manner. The tail-like rays are not retractile, and they are rigid and coarse compared with those of *Actinophryens*. They are simple and unbranched, except at their origin, and they are cylindrical, of uniform breadth, and less uniform length. When torn from the body they are observed to originate from a common stock attached to a rounded eminence.

"Several forms of the *Ouramœba* were observed, but it is uncertain whether they pertain to one or several species. One of these forms had an oblong ovoid body about 1-8th of a line long and 1-12th of a line broad. The tail-like rays formed half a dozen tufts, measuring in length about the width of the body. The latter was so gorged with large diatoms, such as *Navicula viridis*, together with the desmids and confervæ, that the existence of a nucleus could not be ascertained. The species may be distinguished with the name OURAMŒBA VORAX.

"A second form, perhaps of different species, moved actively and extended its broad pseudopods like *Amœba princeps*. When first viewed beneath the microscope it appeared irregularly globular and about the 1-14th of a line in diameter. It elongated to the 1-6th of a line, and moved with its tail-like appendages in the rear. These appendages formed five tufts about the 1-25th of a line long. The interior of the body exhibited a large contractile vesicle and a discoid nucleus. This second form may be distinguished with the name *OURAMŒBA LAPSA*.

"Another *Ouramœba* had two comparatively short tufts of three moniliform rays."

On April 20 of the following year (1875) Leidy again made an oral communication to the Philadelphia Academy in which he gave the characters of the genus Ouramœba and of two species *vorax* and *botulicauda,* and declared that his *lapsa* of the previous year was in no wise different from *vorax.* The printed communication contains figures of *Ouramœba vorax* and *botulicauda,* the first ever published of this interesting organism.

After an interval of four years the United States Geological Survey published in sumptuous form Leidy's great work, "Fresh-water Rhizopods of North America," illustrated with 48 plates, on number 9 of which are found his drawings of *Ouramœba,* while his descriptions cover pages 66 to 72.

This discovery of this amœba by Leidy is, however, the first for America only, for be it noted that the distinguished student of the Rhizopods, William Archer, on February 15, 1866, demonstrated before the Dublin Microscopical Club a protozoan rhizopod which he called *Amœba villosa* (Wallich) having "a large and numerous tuft of very long prolongations issuing from just behind the villous patch. * * * He thought it could be seen that these curious fasciculi were not composed of foreign bodies either issuing from or penetrating into the *Amœba,* but were really linear prolongations of the sarcode itself. * * * This observation, *quantum valeat,* seems possibly to point to a still greater differentiation of parts than has yet been observed in this remarkable form."

Again, on February 24, 1870, Archer described another specimen of *A. villosa* from the villous posterior end of which "were given off a number, probably about a dozen, of long, very fine, linear pseudopodial (?) processes. * * * These were much finer and more delicate than the seemingly somewhat similar, though coarser, processes recorded * * * in this form on a previous meeting."

Further, on 25 September, 1873, Archer again brought this amœba to the attention of the Dublin Microscopical Club, the especial interest "consisting in the projection from the *posterior* end of a number of linear prolongations of the body substance ('like a bundle of *dipt-candles,* if the candles were of varying lengths')."

Archer's attention being called to an abstract published in the *Monthly Microscopical Journal,* November, 1874, of Leidy's first

note, he brought to the notice of the Dublin Microscopical Club on 19 November, 1874, his remarks on a similar form to which, under the name of *A. villosa,* he had called the attention of the Club on 15 February, 1866, and again on 24 February, 1870, and more recently on 25 September, 1873. From the brief description given in the abstract Archer concluded that both he and Leidy had chanced on the same organism.

Archer, having communicated to Leidy his previous discoveries, the latter in his second note above referred to (1875) agrees with Archer that they were both working on the same animal, but maintains his belief that it does not belong to the genus *Amœba,* but that there must be set up for it a new genus, *Ouramœba*—tailed *Amœba.*

Prior to the meeting of the Dublin Microscopical Club on January 20, 1876, Archer had thought that the much-discussed filaments were contractile, but on this day he exhibited a specimen in which, after staining, no contraction had taken place. However, his material abounded with specimens of the ordinary *A. villosa* which were, "the appendages apart, quite identical with the so-called *Ouramœba.*" So it seems that Archer never really understood what these filaments are.

That other distinguished student of the Protozoa, Dr. Wallich, having complained (1875) that Leidy had redescribed his *Amœba villosa* as his (the latter's) *Ouramœba,* Leidy attempted in an oral communication before the Philadelphia Academy (October 5, 1875) to set the matter clear. It seemed that Wallich, not having as yet seen Leidy's figures, thought that the latter had reference to the ordinary short villous processes at the multi-rayed star-shaped end of *Amœba villosa.* These processes do as a matter of fact often look like short fine fungous threads—so the present writer thought the first time that he ever saw them. However, Leidy's figures (1875) made it clear that the two forms were absolutely different.

While it is clear that Leidy in his earlier papers (1874 and 1875) recognized that the tufted structures at the rear of his specimens were not protoplasmic, since they were non-retractile, it is equally clear that he did not know what they were. However, in his great book he says on this point: "Filaments flexible, cylindrical, tubular, inarticulate or articulate, resembling the mycelial threads of fungi, perfectly

passive, and neither retractile nor extensile." * * * "When first seen I regarded the animal as an *Amœba proteus,* dragging after it a bundle of mycelial threads. The recurrence of several individuals led me to examine the animal more attentively, when I came to the conclusion that the threads were part of its structure."

It may be well here to give Leidy's full description of this remarkable amœba, since it may not be accessible to most students: "The filamentary caudal appendages of *Ouramœba vorax* consist of from one to half a dozen distinct tufts, usually collected into a single bundle trailing longitudinally behind the body. * * * Each tuft is composed of from a pair to six or more filaments emanating from a common point or stem, from which they divide and more or less diverge. The filaments are of variable length, not only in the same individual, but also proportionately with the body in different individuals. Sometimes they are few and short or long; more frequently they are numerous and as long as the body, or longer. They are straight, curved, and often irregularly bent; cylindrical and blunt, or sometimes acute or swollen at the end. They are mostly simple from their point of origin, but sometimes branch off from near the latter, and rarely elsewhere. Sometimes an individual is seen in which the filaments appear irregularly contracted at one or more points, and bent or twisted, as if in these positions they had been injured or become atrophied. * * * In structure, the caudal filaments of *Ouramœba vorax* consist of a colorless membranous tube with pale granular contents, mingled with a variable proportion of oil-like molecules. The latter sometimes increase to considerable drops elongated in the course of the enclosing tube. * * *

"The mode of fixation of the caudal filaments is difficult to comprehend. In a detached tuft, the root appeared to be continuous with a ball of homogeneous protoplasm. * * *

"In the movements of *Ouramœba* the caudal filaments are entirely passive, and are usually dragged along behind it. Sometimes in varied movements of the animal the tufts of filaments become more or less separated at their root to a greater distance than usual, and widely diverge from one another. * * *

"The caudal filaments present so much resemblance to the mycelial threads of fungi that I have suspected they may be of this nature, and

parasitic in character, due to the germination of spores which had been swallowed as food. I have repeatedly recognized, among the food of various *Amœbæ,* different kinds of fungus-spores, and it is not unlikely that these lowly creatures may be infested with fungus-parasites, just as we frequently find to be the case with insects. Even the constancy in the extension of the filaments from a particular part of the body is no objection to the conjecture, for in insects we observe certain species of Sphæria growing as constantly from the head. There is, however, perhaps, an important objection to this view, and that is, the caudal filaments do not grow from a mycelium within the protoplasmic mass of the body of the animal."*

In 1885 Gruber described several specimens of *Amœba binucleata* in which could be seen large numbers of short colorless thread-like or rod-like bodies of uniform thickness wholly within the protoplasm. These Gruber thought to be mold-hyphæ living symbiotically within the amœbas.

When treated with osmic acid an interesting change took place: for, as the acid caused the protoplasm to contract, the rods were made to project outside the ectosarc like bundles of needle-shaped crystals. For this Gruber had no explanation save to conjecture that his specimens might be something like Leidy's, in which the threads projected from the living specimens were recognized by him (Gruber) as plainly mold-hyphæ.

In his excellent figures, Gruber shows these threads magnified 300 times (the amœba here measuring 2 x 3 inches) as mere lines without lumina or appreciable thickness. Even in figures drawn under a magnification of 550 diameters a lumen could hardly be distinguished with the naked eye, and in no case could septa be seen. Whatever the explanation of these phenomena, it is quite clear that we do not here have structures parallel with those in *Ouramœba.*†

We now come to a consideration of the question, "What is *Ouramœba?*" "Is it a valid genus?" It has been shown that Archer conjectured that the prolongations from his specimens were stiff protoplasmic processes, such as are found in *Actinophrys.* In the quota-

*Rhizopods, page 79.

†Gruber, August. Studien über Amöben. Zeitschrift für Wissenschaftliche Zoologie 41: 210. 1885.

tions from Leidy it is clearly seen that he was half-way convinced that the processes were fungous threads—a thing plainly to be seen in his elegant figures—but he never clearly gave himself up to this conclusion.

However, this matter has been settled beyond the reach of controversy by Poteat in the second of his papers (1898) previously referred to. In this paper by figures and description he clearly shows that these filaments always arise from spores imbedded in the protoplasm, and that a tuft of filaments arises by the branching of a stalk originating from such a spore. The hyphæ in his specimens were all non-septate, in Leidy's specimens and mine plainly segmented. The creatures sometimes lost their tufts of filaments, but Poteat found that neither the molds nor the amœbas were in any wise affected by the separation.

Again, Poteat's specimens agreed with Leidy's, Archer's, and mine in that the filaments took no active part whatever in the movements of the amœba, being entirely passive, dragged about by the rhizopod, and shifted as it changed its position and shape.

In short, Leidy's *Ouramœba* falls to the ground; it is simply an ordinary *Amœba* which has ingested mold spores, and these in turn have sprouted and formed rudimentary mycelia, nourished in part, as Poteat conjectures, by the wastes of the host. Archer's specimens were *A. villosa*, Leidy's (judging by his figures) were *A. proteus*, as were Poteat's, and as my two dozen specimens all were.

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NOTE.—The Proceedings of the Dublin Microscopical Society were published in the various issues of the Quarterly Journal of Microscopical Science.

NOTES ON THE HERPETOLOGY OF NORTH CAROLINA

By Karl Patterson Schmidt

An expedition of Cornell students, under Professor G. D. Harris of the Department of Paleontology of that university, visited the coastal plain of North Carolina in the summer of 1915 to study the geology and collect Tertiary fossils from some of the famous localities of the State. Dr. A. H. Wright of the Department of Zoölogy provided the author of these notes with an outfit for collecting and preserving vertebrates, with the result that a few herpetological specimens were added to the University museum.

Advantage was taken of every possible opportunity to search for cold-blooded vertebrates, but as this was essentially a subordinate activity, the specimens are few in number and from widely scattered localities. While all of the species observed are listed, the chief interest and value of the records lie in the comparative rarity of certain of the Ophidian forms.

Several specimens are due to the interest taken by other members of the party, and the writer owes especial thanks to Mr. Axel Olsson, with whom he was chiefly associated while in the State. A few specimens collected in North Carolina by Mr. Francis Harper in the summer of 1913, and (in part) identified by the writer, are included in the following list.

Identification of the material has been made by means of Cope,[1] Ditmars,[2] and Dickerson,[3] while C. S. Brimley's Keys to the Amphibia and Reptilia of the State,[4] and his recently published State list,[5] have proved most useful in the study. Reference has been made to C. S. Brimley's "Notes on Turtles of the Genus Pseudemys"[6] and "The Box Tortoises of Southeastern North America."[7] Dr. A. H. Wright has kindly confirmed the identification of doubtful specimens.

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   Crocodilians, Lizards, and Snakes of N. A., Report U. S. Nat. Mus., 1898.
2. Ditmars, R. L. The Reptile Book.
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AMPHIBIA

URODELA

1. *Manculus quadridigitatus* (Holbrook).

Three young specimens about an inch long were found under dead leaves in the sink next the "Natural Well," two miles S. W. of Magnolia (Duplin County), July 10, 1915.

2. *Desmognathus fusca* (Rafinesque).

Two specimens were taken under leaves on the sloping side of the Natural Well, Magnolia, July 10, 1915.

ANURA

3. *Bufo lentiginosus* (Shaw).

One specimen was taken by Mr. Francis Harper at Shackleford Banks, Beaufort, August 3, 1913.

One adult and one young specimen are from Brown's Island, Carteret County, August 9, 1913, collected by Mr. Francis Harper.

Two small specimens came from Gloucester, taken August 10, 1913, by Mr. Francis Harper.

One adult and three recently transformed specimens were taken near the Natural Well, July 10, 1915.

It has seemed preferable to refrain from further diagnosis of these specimens at present. They are *not lentiginosus lentiginosus*, and all seem much closer to *l. americanus* than to the form considered common on the coastal plain, *l. fowleri*.

4. *Bufo quercicus* (Holbrook).

One full-grown specimen, almost black and without markings, was taken July 10, 1915, at the Natural Well.

5. *Acris gryllus* (Le Conte).

This species was seen at Camden Point, at the junction of the North River with Albemarle Sound, July 4, 1915.

Six specimens were taken by Mr. Francis Harper, August 10, 1913, at Gloucester.

6. *Hyla cinerea* (Daudin).

The chorus of this species was at full strength at Camden Point, July 4, and at New Bern, July 11, 1915.

Three specimens were taken at Camden Point.

7. *Hyla versicolor* (Le Conte).

The note of this species was heard at Camden Point, July 4, 1915, but no specimens were secured.

8. *Rana sphenocephala* (Cope).

I have one specimen from the mainland at Beaufort, September 10, 1913, collected by Mr. Francis Harper.

Two full-grown specimens were taken July 4, 1915, at Camden Point.

One large and two small specimens were captured at the Natural Well, July 10, 1915.

9. *Rana clamata* (Daudin).

Two adult specimens were taken in the water at the Natural Well, July 10, 1915.

10. *Rana catesbeana* (Shaw).

One specimen comes from the Natural Well, July 10, 1915.

REPTILIA

TURTLES

11. *Chrysemys concinna* (Le Conte).

This species was abundant in Lake Waccamaw, inhabiting the shallow water, especially the area covered by lily pads (*Nymphæa sagittaefolia*).

One adult specimen was taken July 8, 1915.

12. *Chrysemys scripta* (Schoepf).

Adults of this species were associated with C. concinna noted above. Three young specimens, carapace about two inches in length, were taken by Mr. Axel Olsson in a small run tributary to Lake Waccamaw, July 8, 1915. In contrast with the habits of the adults of this and the above species, which were extremely wary, these were quite indifferent to our approach. All three agree excellently with Ditmars' figure.[8]

13. *Malacoclemmys centrata* (Daudin).

Two small specimens were taken by Mr. Francis Harper, at Beaufort, summer of 1913.

14. *Clemmys guttatus* (Schneider).

One specimen was taken by Mr. Francis Harper, September 10, 1913, at Beaufort (mainland).

Another, taken July 9, 1915, in a small roadside run, at Camp Perry, near Jacksonville, was found by Mr. C. P. Alexander.

15. *Terrapene carolina* (Linn.).

One adult specimen was found in a pool in the road near Councils (Bladen County), July 9, 1915.

16. *Caretta caretta* (Linn.).

A small specimen comes from Beaufort, summer of 1913, taken by Mr. Francis Harper.

LIZARDS

17. *Anolis carolinensis* (Cuvier).

Mr. Francis Harper collected a small specimen from the mainland at Beaufort, September 10, 1913.

One specimen from the Natural Well was taken July 10, 1915. This species was also observed at Lake Waccamaw.

18. *Ophisaurus ventralis* (Linn.).

Two specimens came from Piver's Island, Beaufort, taken in August, 1913, by Mr. Francis Harper.

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8. Ditmars, R. L. The Reptile Book, plate XVI.

19. *Cnemidophorus sexlineatus* (Linn.).

A small specimen from Carrot Island, Beaufort, August 25, 1913, was taken by Mr. Francis Harper.

A very dark specimen, the lines almost obsolete, was found in a typical blueberry-cactus environment, at Bridgeton, opposite New Bern, July 11, 1915.

20. *Lygosoma laterale* (Say).

A single specimen, the only one seen during the summer, was taken under wet leaves on the slope of the Natural Well, where it was associated with *Desmognathus fusca* noted above, also on July 10, 1915.

21. *Plestiodon quinquelineatus* (Linn.).

Specimens of this species were seen in a situation remarkably wet and marshy for a lizard, on Camden Point, near the mouth of the North River, July 4, 1915. Only one was captured.

SNAKES

22. *Thamnophis sirtalis sirtalis* (Linn.).

The only garter snake seen on the trip was a very dark and obscurely striped sirtalis, best referable to the typical variety. The specimen was taken on a hummock in the swampy forest of Camden Point, July 4, 1915.

23. *Opheodrys æstivus* (Linn.).

Two specimens were seen and one taken at Camden Point, July 4, 1915.

24. *Lampropeltis doliatus* (Linn.).

One specimen of this handsome snake was found by Mr. Axel Olsson on the low bluff at Lake Waccamaw, July 8, 1915. The coloration of this snake is that of the typical *L. doliatus doliatus*, with an approach to Cope's *parallelus* anteriorly; reference to A. E. Brown's discussion of the variation in this species,[9] however, proves it to be *L. doliatus coccineus*, with which it agrees in number of gasterosteges and in the absence (frequent in that subspecies[10]) of the loral plate.

25. *Lampropeltis getulus getulus* (Linn.).

One medium-sized specimen was taken in woods bordering the Neuse River, about nine miles below New Bern, by Messrs. E. R. Smith and Bayard Taylor, July 9, 1915.

26. *Farancia abacura* (Holbrook).

A large specimen of this snake was found freshly killed on the bank of the Chowan River, near Tunis, by Messrs. Axel Olsson and Bayard Taylor, July 20, 1915.

27. *Cemophora coccinea* (Blumenbach).

A specimen of this species was found in a rotten pine log just above the Natural Well, at Magnolia, July 10, 1915.

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9. A. E. Brown. A Review of the Genera and Species of American Snakes North of Mexico, Proc. Acad. Nat. Sci., Phil., 53: 71. 1901.

10. C. S. Brimley. Notes on the Scutellation of the Red King Snake, *Ophibolus doliatus coccineus* Schlegel, Jour. Elisha Mitchell Soc., 21: 145. 1905.

28. *Rhadinea flavilata* (Cope).

One specimen of this rare species was found under a pine log near Councils (Bladen County), July 9, 1915.

29. *Tantilla coronata* (Baird and Girard).

A single specimen was found in the same log with the *Cemophora* noted above, at the Natural Well, July 10, 1915.

CORNELL UNIVERSITY, ITHACA, N. Y.

THE LAUREL OAK OR DARLINGTON OAK *(QUERCUS LAURIFOLIA MICHX.)*

By W. C. Coker

Quercus Laurifolia is one of the handsomest and most ornamental oaks to be found in any country, and it is rapidly growing in popularity as a street and lawn tree. This is the tree that is thought by many people in the Pee Dee section of South Carolina to have originated near the town of Darlington, in the county of that name, and, based on this belief, the name Darlington Oak has gained a rather wide currency. In their recent catalog the well known nursery firm of P. J. Berckmans Company, of Augusta, Ga., list this tree as "*Quercus Darlington,*" and say of it: "This is a very handsome form of Evergreen, or Live Oak. The tree is of more upright growth than the Live Oak. A magnificent species, and very popular wherever known." One would suppose from this that the tree was closely related to the Live Oak *(Quercus virginiana)*, but it really belongs to an entirely different group of oaks, and is most nearly related to the Willow Oak *(Quercus Phellos)* and Water Oak *(Q. nigra)*.

The supposition that the tree originated at Darlington, and is peculiar to that section, is likewise an erroneous one. The home of the tree is a strip of varying width along the southern coast from Virginia to Louisiana, and Darlington is not even included in its native area. The source of the error seems to be in the early introduction of the Laurel Oak into Darlington as an ornamental, and their great popularity and increase there. The species has now become established as wild at Darlington and nearby places, such as Springville, but there are no old trees in the woods in that section, and the zone in which it is really native does not come probably within some thirty or forty miles of Darlington.

To Mr. W. D. Woods, of Darlington, one of the sincerest lovers of trees, as well as most indefatigable champions of their rights, is largely due the fact that the real beauty and value of the Darlington Oak has come to be so extensively appreciated. Mr. Woods is still, I think, somewhat skeptical as to the identity of the Dar-

QUERCUS LAURIFOLIA, ABOUT 25 YEARS OLD, SUMMER CONDITION.

QUERCUS LAURIFOLIA, ABOUT 25 YEARS OLD, WINTER CONDITION.

lington Oak with the Laurel Oak, but he is open-minded enough to have gathered for me what information he could concerning the introduction of the tree into Darlington. He writes me that Mrs. Charles A. Dargan, a lady of superior intelligence, informs him that somewhat over one hundred years ago her grandfather brought either the acorns or the young plants from the low country, and that they were introduced into Darlington in that way. Mr. Woods also says that "about the same time Mr. Moses Sanders brought some Live Oak acorns from the low country and planted them out, and I am very sure that all the Live Oaks in the immediate vicinity came from them. The largest one of these Live Oaks is nearly thirteen feet in circumference. There are two Darlington Oaks on the old Gibson place, planted about the same time, that are nearly seventeen feet around." This Live Oak and the two Darlington Oaks are "between four and five hundred feet apart, growing in identically the same soil, and the difference in the size proves the Live Oak to be considerably slower in growth" than the Darlington Oak. "These Gibson trees are the largest Darlington Oaks that we have, and are still in fair order."

Further interesting observations by Mr. Woods are as follows: "One of the remarkable things about the Darlington Oak is its ability, not possessed by any of the others, to take possession of a piece of land and literally cover it with young trees. It is a very prolific bearer of acorns and every acorn can be counted on to make a tree. Then, too, the comparative ease with which it can be transplanted, outside of its matchless beauty, renders it a tree of inestimable value. The place in Springville where Captain Coker once resided is almost entirely covered with them, and they are spreading in almost every direction. The Willow Oak is a magnificent tree, but produces very few acorns and is never found in any considerable numbers. I tried, for some years, to get some of the acorns before I succeeded, and now have from 500 to 1,000 seedlings. There are quite a number of places where the Darlington Oak prevails, and right in the town you could gather the acorns by the barrel; in fact, if it were possible to gather them you could ship a car-load of them, and they never fail to bear."

Largely through the activities of Mr. Woods, Darlington has now become the center for the distribution of this fine oak, and they are

being planted in many cities such as Columbia, Charleston, and New Orleans. As Mr. Woods says, the tree is a very heavy bearer of acorns, of high vitality, and, in contrast to most other trees, seems never to miss a good crop.

One of the most remarkable qualities of the Laurel Oak is its habit of holding its leaves through the entire year throughout most of its range. Towards its northern limit and when planted outside of the coastal plain this habit is modified to a varying degree, depending on the climate. In the low country of South Carolina and along the gulf to New Orleans the tree is nearly or completely evergreen, but at Darlington and Hartsville, S. C., the leaves fall slowly through the winter, usually beginning at the tips of the branches and proceeding inwards, so that by February or March only the center remains decidedly green, with scattered green leaves in the peripheral parts. I have planted one of these trees here in Chapel Hill, N. C., where spring is about eight days later than at Hartsville, and about two-thirds of its leaves are gone by spring. On the other hand, young Live Oaks brought by me to Chapel Hill have held their leaves longer. Just as the buds begin to break in the spring both of these species rapidly drop their remaining leaves, and for a few days are almost naked.

I have never seen published a good illustration of the Laurel Oak as it stands in the open, and have thought it worth while to accompany these notes with several photographs of the trees as they appear in Darlington and Hartsville. Plates 2 and 3 are of the same tree growing in the lawn of Mr. J. J. Lawton, Hartsville, S. C., showing its summer and winter condition. Plate 4 is of a tree growing in an open field in Darlington, S. C., and Plate 5 is of an old tree in a lawn in Darlington.*

CHAPEL HILL, N. C.

*The cost of the plates has been borne by Maj. J. L. Coker, of Hartsville.

Quercus laurifolia, About 60 Years Old.

Quercus laurifolia, About 110 Years Old.

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PROCEEDINGS OF THE FIFTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT THE STATE AGRICULTURAL AND MECHANICAL COLLEGE, WEST RALEIGH, N. C., FRIDAY AND SATURDAY, APRIL 28 and 29, 1916

The Executive Committee—President A. S. Wheeler, Vice-president W. A. Withers, and Secretary-treasurer E. W. Gudger, *ex officio;* Z. P. Metcalf and W. C. Coker—met at 2:45 p. m. on Friday. The Secretary-treasurer reported the finances of the Academy to be in better condition than last year; and that the membership January 1, 1914, was 69, that 6 members were lost by nonpayment of dues and 1 by removal from the state, while 10 applicants were admitted; the membership on January 1, 1915, being 72.

An invitation to meet at the University of North Carolina, Chapel Hill, in 1917 was unanimously accepted. The following applicants for membership were then unanimously elected:

1. Andrews, Rev. Theodore, Lexington.
2. Balderston, Mark, Professor of Physics, Guilford College.
3. Beardslee, H. C., Professor in Asheville School for Boys, Asheville.
4. Bell, J. M., Professor of Physical Chemistry, University of North Carolina, Chapel Hill.
5. Brewer, Charles E., President Meredith College, Raleigh.
6. Browne, W. H., Jr., Professor Electrical Engineering, A. and M. College, West Raleigh.
7. Bruner, E. Murray, United States Forest Examiner, Lenoir.
8. Detjen, L. R., Assistant Horticulturist, Experiment Station, West Raleigh.
9. Gray, Dan T., Chief Division Animal Industry, Experiment Station, West Raleigh.
10. Henderson, Archibald, Professor of Mathematics, University North Carolina, Chapel Hill.

11. Johnson, E. D., Head Department Science, City High School, Asheville.
12. Kaupp, B. F., Professor of Poultry Science, A. and M. College, West Raleigh.
13. Lake, J. L., Professor Physics, Wake Forest College, Wake Forest.
14. Nowell, J. W., Professor of Chemistry, Wake Forest College, Wake Forest.
15 Pillsbury, J. P., Professor of Horticulture, A. and M. College, West Raleigh.
16. Randolph, Mrs. E. O., Elon College.
17. Randolph, Edgar E., Analytical Chemist, Elon College.
18. Rhoades, Verne, United States Forest Examiner, Asheville.
19. Riddick, W. C., Professor Civil Engineering, A. and M. College, West Raleigh.
20. Roberts, G. A., Professor of Veterinary Medicine, A. and M. College, West Raleigh.
21. Ware, J. O., Instructor in Entomology, A. and M. College, West Raleigh.
22. Wilson, Miss Margaret, Head Department of Science, High School, Wilson.
23. Wolf, F. A., Professor of Plant Pathology, A. and M. College, West Raleigh.

President Wheeler called the Academy to order in regular session at 3:15 and appointed the following committees: Resolutions, W. C. Coker, J. J. Wolfe, and George W. Lay; Auditing, Bert Cunningham, J. E. Smith, and J. S. Downing; Nominating, C. W. Edwards, Collier Cobb, and Franklin Sherman, Jr. The reading of papers was then begun with 24 members and a number of visitors present. Adjournment was had at 5:15, when seven papers had been read, that the members might take an automobile ride over the city as the guests of the local members.

At 8:15 p. m. the Academy convened in evening session in the Y. M. C. A. auditorium, where it was cordially welcomed to the A. & M. College by President D. H. Hill. Then President A. S. Wheeler of the Academy gave his presidential address on "The Critical Dyestuff Situation" with a demonstration of materials. Next Professor E. W. Gudger read his paper on "Echeneis or Remora: a Living Fish-Hook," illustrated with specimens and photographs of old figures.

The Academy met in annual business session at 9:10 Saturday morning with some 25 members present. The minutes of last meeting were read and approved. The place of next meeting was announced and the list of new members—the largest but one in the history of the Academy—was read. The Treasurer then read his

annual report as follows, and the Auditing Committee reported it correct and all accounts in order.

REPORT OF E. W. GUDGER, TREASURER, 1915-1916

RECEIPTS	
Balance last audit	$ 160.97
Dues since last audit	97.00
Interest S. B. account	4.22
Total receipts	$ 262.19
Less expenses	95.41
Balance	$ 166.78

EXPENSES	
Proceedings 1915	$ 75.00
Secretary's expenses 1915 meeting.	5.90
Secretary's dues, 1914-1915	2.00
Printing	4.00
Postage	7.51
Clerical help	1.00
Total expenses	$ 95.41

RESOURCES	
Savings bank balance	$ 108.29
Checking bank balance	58.49
Total	$ 166.78
Dues unpaid (about)	20.00
Stamped envelopes (about)	9.00
Estimated resources	$ 195.78
Estimated debts	91.25
Estimated balance	$ 104.53

OUTSTANDING DEBTS	
Proceedings 1916	$ 75.00
Printing	6.25
Miscellaneous (about)	10.00
Total (about)	$ 91.25

The Nominating Committee next reported and the following officers were elected for 1916-17: President, F. P. Venable, Professor of Chemistry, University of North Carolina; Vice-president, H. C. Beardslee, Asheville School for Boys; Secretary-treasurer, E. W. Gudger, Professor of Biology, State Normal College; additional members of Executive Committee: J. E. Smith, Assistant in Geology, University of North Carolina; E. O. Randolph, Professor of Geology and Biology, Elon College; Bert Cunningham, Head of the Department of Science, Durham High School.

The Resolutions Committee then reported as follows:

1. WHEREAS, in the death of Joseph Austin Holmes the North Carolina Academy of Science has lost a most honored member—one who in his life exemplified what we believe to be the true ideals of science, in that, with complete devotion of his superb industry and rare gifts to the public good, he sacrificed ease, comfort, and even life itself that the life of his fellows might be more secure:

Therefore be it resolved, That the Secretary be instructed to extend to the family of Dr. Holmes the profound sympathy of this Academy and to incorporate a copy of this resolution in the minutes of this meeting.

2. *Resolved,* That the North Carolina Academy of Science hereby express to the officers and faculty of the A. and M. College and to the citizens of Raleigh their grateful appreciation of their abundant hospitality and of the many

kindly and thoughtful acts which have made this meeting one of the pleasantest in our recollection.

The Committee on Membership appointed in 1915 was continued for another year as follows: Chapel Hill, A. H. Patterson; Durham, Bert Cunningham; Greensboro, Miss Gertrude Mendenhall; Guilford College, Mark Balderston; Raleigh, C. S. Brimley and Z. P. Metcalf; State at large, F. Sherman, Jr., and the Secretary.

Professor J. J. Wolfe then offered the following motion, which, after some discussion, was adopted:

That the Academy take measures to secure representation in the South Eastern Association of Schools and Colleges, and that the Secretary, or, in case of his inability to attend, the President, shall represent the Academy. That the Academy pay all expenses attendant upon such representation.

It was the sense of the Academy that some scientific body be represented in the above association to offer advice as to the making out of science courses for southern high schools, and by the preceding motion the North Carolina Academy of Science offers its services.

Professor Collier Cobb called attention to the fact that no adequate mapping out of our Atlantic Coastal Plain has ever been made although very necessary from a standpoint of preparedness. On his motion the President appointed a committee to urge this matter on our congressmen. Professors Collier Cobb, E. W. Gudger, and H. C. Beardslee were named as the committee.

At 9:55 the reading of papers in the joint session of the Academy and the North Carolina Section of the American Chemical Society was begun. All the chemical papers on the Academy program and those on the Chemists' list which were of general interest were read, President Wheeler presiding. At 10:45 the two bodies separated, the reading of papers in the Academy continuing with Vice-president W. A. Withers in the chair. All papers having been finished or called for, the Academy adjourned at 1:33 p. m. Of the 23 papers on the program only 3 were read by title.

The membership of the Academy at the present time (88) is as follows, those present at this meeting being indicated by a *:

Allen, Prof. W. M.; Andrews, Rev. Theodore; Balcomb, Prof. E. E.; *Balderston, Prof. Mark; *Beardslee, Prof. H. C.; *Bell, Prof. J. M.; Brewer, Pres.

Chas. E.; *Brimley, C. S.; *Brimley, H. H.; *Browne, W. H., Jr., Prof.; Bruner, E. Murray; Bruner, S. C.; Cane, Prof. Wm.; *Carruth, F. E.; *Clapp, S. C.; *Cobb, Prof. Collier; Cobb, Wm. B.; *Coker, Prof. W. C.; Collett, R. W.; *Cunningham, Prof. Bert; *Detjen, Mr. L. R.; *Downing, Prof. J. S.; *Edwards, Prof. C. W.; Farmer, Prof. C. N.; Field, R. H.; *George, W. C.; *Gray, Dr. Dan T.; Gove, Dr. Anna M.; *Gudger, Prof. E. W.; Hammel, Prof. W. C. A.; Henderson, Prof. Archibald; *Herty, Prof. C. H.; Hickerson, Prof. T. F.; Hoffmann, S W.; Holmes, J. S.; *Hutt, Dr. W. N.; Ives, Prof. J. D.; Johnson, Prof. E. D.; Kaupp, Prof. B. F.; *Kilgore, Prof. B. W.; Lake, Prof. J. L.; *Lanneau, Prof. J. F.; *Lay, Rev. George W.; *Leiby, R. W.; Lewis, Dr. R. H.; Lyon, Prof. Mary; McIver, Mrs. Chas. D.; MacNider, Prof. W. de B.; MacNider, Dr. G. M.; Mendenhall, Prof. Gertrude; *Metcalf, Prof. Z. P.; Mills, Dr. J. E.; Newman, Prof. C. L.; Nowell, Prof. J. W.; Patterson, Prof. A. H.; Pegram, Prof. W. H.; Pillsbury, Prof. J. P.; *Plummer, Mr. J. K.; Poteat, Pres. W. L.; Potwine, Miss Elizabeth B; *Pratt, Dr. J. H.; *Randolph, Prof. E. O.; Randolph, Mrs. E. Oscar; Randolph, Prof. Edgar E.; Rankin, Dr. W. S.; Rhoades, Mr. Verne; *Riddick, Prof. W. C.; *Roberts, Dr. G. A.; Robinson, Miss Mary; *Sherman, Mr. Franklin, Jr.; *Shore, Dr. C. A.; *Smith, J. E.; *Spencer, H.; Stiles, Dr. C. W.; Strong, Prof. Cora; *Totten, Mr. Henry R.; Venable, Prof. F. P.; *Ware, J. O.; *Wheeler, Prof. A. S.; *Williams, Prof. L. F.; Wilson, Prof. H. V.; *Wilson, Miss Margaret; *Winters, Prof. R. Y.; *Withers, Prof. W. A.; *Wolf, Prof. F. A.; *Wolfe, Prof. J. J.; Wilson, R. N.; Hobbs, A. W.

In addition to the presidential address, which is published herein in full, the following papers were read:

Some Known Changes in the Land Vertebrate Fauna of North Carolina

BY C. S. BRIMLEY

This paper will appear in full in the next number of this JOURNAL.

The Two Raleigh Amblystomæ Compared

BY C. S. BRIMLEY

	A. punctatum.	A. opacum.
Adults.		
Color.	Brownish black with a double row of yellow spots on back and tail.	Bluish black, with a broken white stripe down each side of back connected with its fellow by white cross bars, not exceeding six in number. White cross-bars on tail.
Size.	Length about 6 to 7 inches, tail about half total length.	Length about 4 inches, tail less than half total length.

Eggs.	Laid in gelatinous masses in water in February.	Not in gelatinous masses, but separate from each other, laid in groups under dead logs in the beds of dried-up pools in October. Adults usually found curled up on eggs.
Larvae.	Develop into adults about July, attaining a length of about 2 inches.	Develop into adults about May, attaining a length of at least 2½ inches.

ARISTOTLE'S ECHENEIS NOT A SUCKING-FISH

BY E. W. GUDGER

The identity of this fish was discussed and date presented to show that it was a goby, while evidence was adduced that the "dolphin's louse," elsewhere referred to by Aristotle in his *History of Animals*, was a sucking-fish. The full paper is nearly ready for publication.

THE ECHENEIS OR REMORA; A LIVING FISH-HOOK

BY E. W. GUDGER

The tendency of this fish to adhere to turtles, sharks, or any large fish by means of its cephalic sucking disk, is made use of in many parts of the world to render easy the catching of fish. A thin cord is tied around the "small" of the tail of the fish and it is set free in the water. Finding a turtle or fish, the fisherman-fish clamps itself fast to it, and both are hauled in by the fisherman. This use of the living fish-hook was traced back to 1494, when Columbus (the first European to see it so used) witnessed its exploits on the south side of Cuba in his second voyage. The paper was illustrated by numerous photographs of illustrations in old books, showing this use of the fish. The completed paper will be published later.

SOME INTERESTING MUSHROOMS

BY W. C. COKER

Several species, new or rare in North Carolina, where shown, with photographs and paintings.

Naucoria sp. A species of this genus, not recorded from this state, has appeared in manured soil in the Arboretum of the Univer-

sity for several years. It is of good size and very resistant to decay, and was tested and found harmless, and if properly prepared so as to get rid of the bitter taste of the gills makes a very pleasant dish. As it begins to appear very early in the season, during April, and before other species of any size are out, it is a valuable addition to our list of edibles. The species seems nearest *N. hamadryas,* but differs from it in some respects.

Clavaria spiculispora Atkinson.

A painting of this species was shown. It was described from our collection of Chapel Hill plants. It is remarkable for the very deep brown color (deepest of any other American Clavaria), and the very long spicules on the spores. We have since found it in the mountains near Black Mountain. It is not known except from this state.

Amanita chlorinosma Pk.

Photographs and paintings were shown to illustrate the great range in size and color of this species. White, greenish, salmon, reddish, and ashy-brown forms occur. All the forms have a distinct odor of chlorine.

Nyctalis asterophora Fr.

A photo was shown of this plant growing on *Russula nigricans.* It is very peculiar in having another mushroom for its host, and in the degenerated gills. The functional spores are not borne on the gills as usual, but on the cap as a fine powder, and are very large and irregular.

VENEREAL INFECTIONS IN ANIMALS

BY G. A. ROBERTS

Observations, investigations and reports indicate very widespread venereal infections in this country and abroad among domestic animals, horses, cattle, sheep, swine, etc. Such infections have been known to exist in the human family for a long time.

Few people have recognized the extent and the manifold results of these infections.

The most extensive investigations and the greatest losses, direct and indirect, in animals have been among dairy cattle and breeding herds.

The specific organism responsible for the infection in cattle has all but universally been accepted as the *Bacillus abortus* (Bang) Many cases of infection with the *B. abortus* are too mild to produce clinical symptoms. The results observed in many such infections, however, are: abortions, including premature births, still births and birth of weaklings; metritis (inflammation of the uterus); and sterilities, temporary and permanent.

Retained "after-birth" is quite common in cattle when expulsion of the fetus occurs during the latter half of pregnancy, owing to the peculiar attachment between fetal membrane and the uterus at this time.

Nymphomania is not uncommon in cows and mares.

The relation of this organism to certain udder diseases and the granular venereal diseases of cattle, to some forms of calf scours and infant diarrheal troubles, has not been determined, but is suspicious of a close relationship.

RESISTANCE AND IMMUNITY IN PLANTS

BY F. A. WOLF

This paper contains a brief summary of the facts which have been correlated with resistance and immunity in plants in attempts to explain the underlying causes. Attention is called to several investigations dealing with morphological differences between susceptible and immune varieties. Consideration is also given to the influence of mineral nutrients in the soil upon resistance. The discussion also includes those causes which reside within the protoplasm of the host plants such as differences in acidity, tanin content, etc., of susceptible and immune varieties. It is believed that too little attention has heretofore been given to the inherent characters of the parasitic organism which determine the virulence of the parasite.

SOME METHODS OF MAKING LANTERN SLIDES

BY Z. P. METCALF

The need of some form of projection in science teaching and the general utility of lantern slides was emphasized. Two methods

of making lantern slides were discussed and examples of various kinds of lantern slides were shown.

TREES AND SHRUBS OF CHAPEL HILL

BY H. R. TOTTEN

There are seventy-four species of native trees found in the Chapel Hill neighborhood. In this number there are fourteen oaks: *Quercus alba, Q. Stellata, Q. lyrata, Q. Michauxii, Q. Prinus, Q. rubra, Q. palustris, Q. coccinea, Q. velutina, Q. falcata, Q. pagodaefolia, Q. marilandica, Q. nigra, Q. phellos.* A hybrid, probably between *Q. phellos* and *Q. falcata*, and one resembling *Q. phellos* X *Q. marilandica* are also found. This is the only known station for the Pin Oak (*Q. palustris*) in North Carolina. There are seven hickories: *Hicoria ovata, H. carolina-septentrionalis, H. microcarpa, H. glabra, H. pallida, H. alba* and *H. cordiformis.*

There are sixty-nine native shrubs. A few of the most interesting are: *Nestronia umbellula, Hydrangea arborescens, Euonymus atropurpureus, Rhododendron catawbiense, Fothergilla major, Robinia nana, Gaultheria procumbens, Gaylussacia baccata* var. *glaucocarpa* and *Symplocos tinctoria.*

ON THE SEXUALITY OF THE FILAMENT OF SPIROGYRA

BY BERT CUNNINGHAM

If zygotes occur in both filaments as the result of scalariform conjugation, the filament is said to be bisexual. This condition is called cross conjugation. All cases reported thus far have been considered as abnormalities on account of their rareness. The writer collected a species in cross conjugation in April, 1915. It has been tentatively identified as *S. inflata.* Professor G. S. West verifies this classification. This shows that bisexuality of the filament does occur in the genus. Bisexuality is due to retarded reduction. In scalariform conjugation reduction occurs in the zygote with the loss of three nuclei, while in lateral and cross conjugation, reduction takes place in the filament and no nuclei are lost. The essential difference between lateral and cross conjugation is that the cells may continue to divide after reduction in the latter, while they do not in

the former. In this respect the filament of *Spirogyra* which cross conjugates is homologous with the sporophyte of higher plants.

THE DIORITES OF THE CHAPEL HILL STOCK

BY JOHN E. SMITH

The specimens described here were obtained north of Chapel Hill where the diorities are found along Bolin's Creek. Some were taken near the inner margin of the zone and some near the creek at the foot of Clover Hill. The primary minerals as shown by the microscope are oligoclase, hornblende, quartz, magnetite, and apatite named in order of their abundance. The apatite occurs as inclusions. The oligoclase contains innumerable minute inclusions occupying most of the area of the crystals except in the narrow marginal zone which are entirely free from them. The parallel striations are in general very narrow and very close together and in some of the zones are invisible. The order of crystallization is as follows: apatite, magnetite, hornblende, oligoclase, and quartz. The secondary minerals are epidote and a small quantity of albite. They are derived from the oligoclase, magnetite, and hornblende by hydration.

The quartz decreases in amount outward from the center of the stock. The lime in the water supply of Chapel Hill is produced from this feldspar. The soils derived from the rocks of this zone constitute the Iredell series and contain little or no potash.

PHYSIOGRAPHY OF THE ISLE OF PALMS (S. C.)

BY E. OSCAR RANDOLPH

The Isle of Palms, situated eight miles to the northeast of Charleston, and connected with that city by a trolley line, has an area of approximately 4,000 acres. This sea-captured land is about six and one-fourth miles in length, and one and one-fourth miles in maximum width, tapering to a decided point at southwestern end. Physiographically, this area is interesting and instructive. In shape it approximates a ham; and by local fisherman it is called "The Ham."

From the mainland the island is separated by a narrow inlet that is wide and deep enough to convey local freight, pleasure, and fishing vessels. This back beach is subjected to no unusual geologi-

cal exigencies except tidal work. The front beach is subjected to wave, tidal, wind, and littoral current agencies. As a result, frequent shore-line configurations are effected. The writer made a number of instructive observations relative to immediate changes of epicontinental shelving between the points of high and low tide respectively.

Two well-defined sand dune ridges traverse the island lengthwise. Physiographically, incipient, migratory, temporary, and fixed dunes are in evidence. Among the flora are found sand arresters and dune fixers. The front beach is continuously attacked by wind and wave action; the interdune area is likewise undergoing change under the influence of wind-trough currents and animal life. The age and stability of the fixed dunes, ranging in height from twenty-five to forty feet, is realized in their supporting luxuriant palm trees.

ALTERATION AND PARTHENOGENESIS IN PADINA

BY JAMES J. WOLFE

At the meeting of this academy in 1913, the writer made a preliminary report on this work. It had then been carried only to the point of demonstrating that tetraspores invariably produce male and female plants. The entire series has now been completed, showing with equal certainty that fertilized eggs produce only tetrasporic plants—thus demonstrating "alteration of generations" in Padina.

In view of the fact that *Padina* grows well only in localities where it normally occurs, in the experiments dealing with parthenogenesis clean oyster shells were attached alongside those bearing unfertilized eggs to serve as controls. The results of both series were in essential respects sufficiently similar to show that all plants recovered were in both cases derived from chance reproductive bodies. Thus, it is fairly conclusively shown that unfertilized eggs, though they germinate quite freely parthenogenetically, never produce mature plants.

No abstracts have been received for the following papers:

Friday noon. George W. Lay.

Zonation in the Chapel Hill Stock. Collier Cobb.

Russulla xerampelina; a study in variation. H. C. Beardsley.

Improvements in the Method of Determining the Heating Value of a Gas (By title). C. W. Edwards.

Magnetic Separation of Minerals. Joseph Hyde Pratt.

Insect Polyembryony (Lantern). R. W. Leiby.

An Apparatus to Illustrate the Cohesion of Water—With Reference to the Ascent of Sap (By title). F. E. Carruth.

Some Recent Feeding Experiments with Cottonseed Products. W. A. Withers and F. E. Carruth.

A Study of Some Nitrifying Solutions (By title). W. A. Withers, H. L. Cox, F. A. Wolf, and E. E. Standford.

A New Industry for North Carolina (By invitation). C. P. Williams.

E. W. GUDGER, *Secretary.*

THE CRITICAL DYESTUFF SITUATION.[1]

By A. S. Wheeler.

The American people are suddenly and rapidly developing a world consciousness. While we may pride ourselves upon our remarkable development into a great and rich nation, yet the growth of cosmopolitanism has not gone on *pari passu* with the growth of our riches. We may think that our splendid educational system has given us an adequate knowledge of the world, yet it is really true that not only are we provincial as a nation, but in our home relations the different sections of our country are provincial. Our knowledge of the physical geography of the world may be fairly adequate, but the significant thing is our grasp of the character of foreign peoples. In spite of our constant contact with European peoples about whom information is so plentiful, they are not wholly understood.

The great European war, however, suddenly forced the United States into a world position. You know as well as I that we have had the habit of refraining from mixing up in European politics. We have had a fear of entangling alliances. We have been satisfied to live within ourselves. Our natural resources have been so great that we have been completely absorbed in their development and exploitation. We have paid little attention, comparatively speaking, to foreign commerce. Foreign houses through their own agents here have bought our grain and other products and have shipped them upon the high seas in their own bottoms. Having lived in a seaport I have a strong appreciation of this fact. We have practically been without a merchant marine. All the profits of transportation have gone to foreigners. Further, our development in manufacturing has not been of an all-round character such as might make us independent of others should we be thrown upon our own resources. Our tariff laws have developed certain manufactures and have throttled others. Wars involving more than two nations have been of so rare an occurence that we have been hitherto very little affected by such events. This has led us into a complacent feeling that war involving

[1]Presidential address before the North Carolina Academy of Science, Raleigh, N. C., April 28, 1916

many nations was unthinkable. We have perhaps exaggerated the growth of the brotherhood of man and have been anticipating an era of universal peace.

Suddenly and with startling rapidity all Europe plunged into war and dragged its colonies in all parts of the world into the savage contest with it. Merchant ships in large numbers were taken off the trade routes and many imports of great value to America were completely cut off. In a remarkably short time we were made to realize the intimate relations which we sustain to the rest of the world. The rich and the poor in every nook and cranny of this great land of ours had occasion to feel personally the loss of something. Either there was something that he could not get or else something for which he had to pay a higher price. This situation is growing. We were shocked only recently when we found that we had to pay 10 cents for a bottle of ink instead of 5 cents. We faced a famine in certain manufactures such as toys, scientific apparatus, lenses, organic chemicals including dyestuffs and medicines, certain textiles, etc., etc.

I am particularly concerned tonight with the dyestuff situation. Every one of us has been affected by the complete stoppage of importations of dyestuffs from Germany and by the nonexistence of an important dye manufacturing industry in our own country. We had been importing annually from Germany 22,000 tons of dyestuffs and 3,000 tons from England, France and Switzerland. Thus we were actually dependent upon Germany since England and France were also cut off, and hence could not send us the little they had been supplying us. It is true that we now get an occasional shipment from Switzerland, but this is not significant. The value of the dyestuffs which we imported from Germany annually amounted to ten million dollars. Now this is not a large sum of money as commerce goes. Woolworth, the ten-cent store man, receives about that sum in one year from candy alone. But the importance of dyestuffs rests in the industries which use them. Of these there are five important ones, textile, leather, paper, paint (including varnish) and ink. Over two million working men and women are employed in these industries and a vast number make their living by using the products of these industries. Coloring agents have become a neces-

sity to us. Our clothing, whether it be of wool, silk, or cotton, we require in a great variety of colors. This has a very practical as well as an esthetic value. If the dye could be suddenly removed from our clothes I am sure we would be shocked by its spotted condition. We call for colors in our carpets, drapery and upholstery. We demand that the leather for bookbinding, shoemaking and upholstery shall be colored red, blue, green and other colors. We call for writing paper in a variety of tints. Blotting papers, crepe and tissue papers and even wrapping papers must be colored. We color our woodwork and make cheap pine wood look like oak, cherry, rosewood or mahogany. Thus we color our floors, inside finish and furniture. For this purpose we get paints, stains and varnishes in any tint that our fancy demands. Then comes the ink industry, with 118 manufacturers producing over eleven million dollars worth of black, blue-black, red, green and violet inks. In all of these industries the actual cost of the dye is a small part of the cost of the dyed material, but its importance is none the less vital.

Being confronted with a dyestuff famine, the question arose, what can we do, what shall we do? The seriousness of the situation was recognized in the early days of the war by textile manufacturers and all others concerned. Owing to the strenuous endeavors of buyers and importers the importation through neutral countries like Holland was resumed, but continued only until March, 1915, when Germany placed an embargo upon the exportation of dyestuffs. We might still obtain dyes if Great Britain would permit us to export cotton and nitric acid to Germany. This deadlock, then, shuts us off completely from German dyes. Anticipating such a possibility, attention was early directed to a home dye industry. This, however, is an industry of great complexity. There are a number of reasons why it can not be established at once or within a short time. There is a lack of raw material, there is the necessity of constructing large plants for carrying out the great variety of processes which are required, there is the need of subsidiary related industries, there is the enlistment of large capital.

As regards capital this is a matter of the first importance. The difficulty here as always is that capital wants reasonable assurance of

success. By this I mean particularly that capital wants protection from disastrous foreign competition after the war. If capital cannot see its way clear to a permanent industry, it will not venture in. As for raw material there has been a great lack in this country. Owing to our reckless and extravagant methods we have wasted vast quantities of valuable material. Finally, the complexity of dye manufacturing may be suggested by the fact that there have been 921 different dyes on the American market, that these are made in a great variety of ways, that each particular process usually consists of many steps, and that for the many by-products there must be a market.

Before considering what Americans have already done since the outbreak of the war and what their prospects for the future are, let us sketch with extreme brevity the history of the coal tar dyes.

The coal tar dye industry originated in England in 1856. W. H. Perkin was attempting to convert an artificial base into the well-known alkaloid, quinine. Chemists are ever busy trying to make in the laboratory what nature makes so easily in plant and animal life. Perkin obtained a reddish powder instead of quinine which, you known, is quite colorless. Surprised by this result, he tried anilin, but this only gave him a black substance, but to his great astonishment alcohol dissolved out of this a most beautiful dye to which was given the name anilin purple or mauve. The name anilin purple is now obsolete. After numerous difficulties were overcome, mauve became a commercial product, the first technical coal tar dye. One-quarter of an ounce is obtainable from 100 pounds of coal. The intermediate products are shown in the table:

Coal	100 lbs.	
Coal tar	10 lbs.	12 ozs.
Coal tar naphtha........	.. lbs.	8.5 ozs.
Benzol	.. lbs.	2.75 ozs.
Nitrobenzol	.. lbs.	4.25 ozs.
Anilin	.. lbs.	2.5 ozs.
Mauve	.. lbs.	0.25 ozs.

Or for one pound of mauve there are required 6,400 pounds of coal. However, a little mauve will go a very long way. Let me add one grain of this violet dye to 630,000 grains (9 gallons) of water. You see what a wonderful tinctorial power it possesses. Let me spray

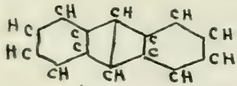
some alcohol upon this paper over which has been dusted some of the same dye. Three years after the discovery of mauve, Verguin in France produced magenta on a commercial scale. Then came Nicholson's blue in 1861, followed in 1863 by the Hofmann violets. Thus within seven years four coal tar dyes of different colors were discovered and became commercial products. From 1875 to 1885 the growth was particularly remarkable, the discoveries being made chiefly by German chemists. In this brief period we have alizarin orange, 1875; the azo dyes such as chrysoidin and naphthol orange, 1875-6; fast red, Ponceaux, Bordeaux, and Biebrich scarlet, 1878-9; phenosafranine, 1878; alizarin blue, 1878; gallein and coerulein, 1878; the eurhodines, 1879; naphthol yellow, 1879; the oxazines, 1879; neutral violet, 1880; the indophenols, 1881; the quinoline dyes, 1881; blue black and tartrazine, 1882; sun yellow, 1883; Congo red, the first direct cotton dye, 1884-5. The first indigo synthesis was made by Baeyer in 1880, but it was not a commercial success.

As you all undoubtedly know there are many dyestuffs found in plants. These are called natural dyes. They have been of great importance, but the synthetic dyes displaced them for several reasons. In the first place synthetic dyes introduced many new shades and tones which were quite unattainable with natural dyes. The synthetic dyes made possible cheaper and simpler methods of dyeing, so that the art of dyeing was no longer a mystery known only to a few, but it became an open profession. Finally, the natural dyes were driven out because they were of an inferior quality. Being extracts of plants they contain other substances which modify the color so that different lots produce varying results. Another very important objection on the score of quality is that the natural dyes do not belong to the group of fast colors. Although indigo is one of the fastest of colors, the natural indigo is made up of a mixture of indigo blue, indigo red and indigo brown. Hence variable results were obtained with the natural indigo. Logwood, once used universally for producing blacks, was fast to washing but not to light or to exposure to weather. In the old days when our black clothing was made with logwood it always faded to a rusty color. The alizarine

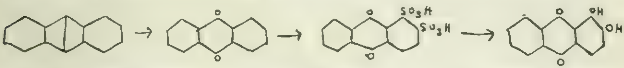
blacks which have displaced logwood are extremely fast dyes. Fustic, which gives yellows and browns, is not a fast dye. Cochineal is a red dye which held its own against the coal tar acid scarlets which first came into use, but when anthracene and chrome scarlets were introduced cochineal was abandoned. They are fugitive colors, therefore, and though in a crisis we may make some use of them, it is clear that they will never be accepted in view of their inferiority to the coal tar dyes. We can easily believe that natural dyes are not fast even if we have had no personal experience with them, when we look about us and see how the green in the grass turns brown, how the green in the leaf turns red, yellow, purple and brown, how the brilliant and varied hues of the flowers fade away to dull browns and blacks. The great superiority of the synthetic dyes has long attracted the attention of the chemist, and a fascinating field of research has been found in the endeavor to produce natural dyes in the laboratory. Two of these, alizarine and indigo, are of such great importance that I wish to run over the main points of their history.

Madder is the root of several species of Rubia, large plantations of which were cultivated in Holland, Asia Minor, Russia, and France. What we know today as alizarine was discovered and obtained from madder by Robiquet and Colin in 1831. In later times it developed as a most important dye, finding application in producing bright red shades on calico mordanted with Turkey red oil. The dye has been popularly called Turkey Red. The annual imports of madder by Great Britain in the period 1859-1868 amounted to five million dollars in value. The world's production at that time amounted to ten million dollars. The most brilliant red and the fastest which can be produced on cotton is obtained by the use of alizarine. It, therefore, very naturally attracted the attention of chemists, for there was the possibility of synthesizing an alizarine which would not only be purer and better, but also cheaper. Two German chemists, Graebe and Liebermann, attacked the problem and in 1869 succeeded in producing it from a coal tar product. If coal tar is subjected to heat, more than fifty substances distill off such as benzol, toluol, carbolic acid, naphthalene and anthracene. This last substance, anthracene, is

a crystalline compound, showing a beautiful fluorescence. It has the formula $C_{14}H_{10}$ with atoms arranged according to the following scheme:



Graebe and Liebermann heated alizarine obtained from madder, passed the vapor over hot zinc dust and obtained a product which they identified as anthracene. This discovery threw the first light upon the nature of alizarine. This occurred in 1868. The next step was to begin with anthracene and pass, if possible, to alizarine. This was accomplished within another year. The first method was not commercially successful and I will pass over it. By the second method anthracene was oxidized to anthraquinone, this was converted into a sulfonic acid with sulfuric acid which is a very cheap chemical, and finally potash converted the sulfonic acid into alizarine. This

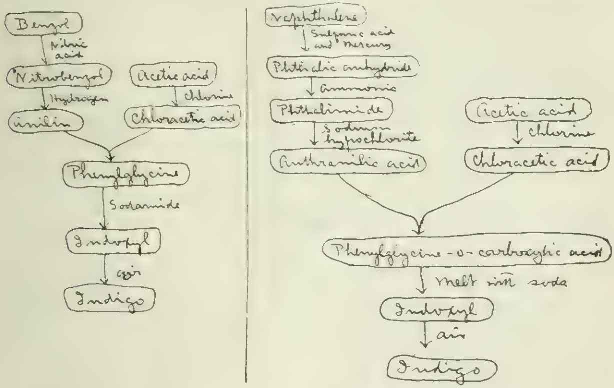


process is remarkable for the few steps involved. Although anthracene constitutes less than one per cent of the coal tar distillation products, yet the world's production is large. England alone in 1913 exported over one-half million pounds. Synthetic alizarine rapidly drove neutral alizarine out of the market. It sold at a price one-third that of madder, and thus many millions of dollars were saved annually. Madder plantations occupied 400,000 acres of land, but now they are producing other crops. Farmers who had never known anything but madder culture were compelled to learn new agricultural pursuits.

The other dye which has attracted the popular attention of the world is indigo. Sir Henry E. Roscoe, in a lecture delivered in 1881 when there was much talk of the possible synthesis of indigo on a commercial scale, stated that the value of the world's annual crop was twenty million dollars. Indigo is obtained from a shrub, three to five feet high, which grows in India, the Philippine Islands, Java, China and Central America. During the period of the alizarine de-

velopment indigo attracted the attention of chemists, especially in Germany, and many syntheses were developed, principally by Professor Adolph von Baeyer of the University of Munich. The twenty-year quest, resulting in 1897 in complete triumph, is one of the romances of science and a striking example of the successful application of theoretical training to industrial problems. Some idea of the struggle may be seen in the fact that 152 patents were taken out in that period. The search was engaged in not only by the chemists in the big dye factories but also by chemists in the universities. Without going into many details I wish to give something of the history of this achievement. One essential in the synthesis of a commercial product is a cheap raw material. In spite of all of the other important discoveries the commercial production of indigo was not a success until it was found in the nineties that naphthalene could be used as the raw material. The first substance which gave hope was cinnamic acid, a crystalline substance occurring in Peru balsam and in storax. A laboratory method was discovered which made this a cheap article of manufacture, but subsequent operations raised the cost of producing the indigo so much that it exceeded the cost of natural indigo. In 1882 a synthesis was discovered which employed orthonitrobenzaldehyde and acetone. The method went smoothly, but serious obstacles arose in making the raw material. All possible methods were tried, but no success was attained. In 1886 another discovery raised hopes again, but these were again doomed after much investigation. Then followed a long period of quiet, but it appeared in 1896 that this field had nevertheless been assiduously worked. A new method of making orthonitrobenzaldehyde had been worked out and the process became commercially successful. But it failed again, and this time on account of the fact that an industry built up on this method could never supply the demand, owing to the limited production of toluol from which orthonitrobenzaldehyde is made. If the supply of toluol were to be increased it would mean quadrupling the supply of benzol, because these products occur in the distillation products of coal tar in the ratio of 4 to 1. However, in view of the current price of gasoline, this might find a market as a motor fuel.

In 1890 a new direction was given to the search by Heumann, who produced indigo by melting phenylglycine with potash. Difficulties again arose and success was again deferred in spite of a vast amount of experimentation. But when phenylglycine-o-carboxylic acid was found to yield indigo smoothly, it required only a few years longer of intense investigation. This substance is made from anthranilic acid and the latter from naphthalene. Since there was an annual waste of 35,000 tons of naphthalene, here was a cheap raw material in sufficient quantity for all possible demands of a synthetic indigo industry. Let us look now at the table for other interesting things in connection with this famous synthesis.



The new method on the right is that of the Badische Anilin u. Soda Fabrik, at Ludwigshafen am Rhein. This company announced in July, 1897, that this process was a complete success. Every step had to be cheapened. They developed a new method of making sulfuric acid catalytically. They improved the process of converting naphthalene into phthalic anhydride. They made chlorine by a new process, the electrolysis of salt. It was not pure, however, but they found that by liquefying it a pure product was obtained. The decline of the natural indigo industry is indicated by the fact that the German works make 95 per cent of the world's consumption.

It is very interesting to note that a new and shorter synthesis is now in operation by the Farbwerke-Hoechst Company. The table on the left shows that benzol is the starting out material. This is converted into nitrobenzol which is changed into anilin. The latter with chloracetic acid gives phenylglycine, and sodamide converts this into indoxyl. Owing to the vast increase in the production of benzol due to war conditions, this is certain to be a permanent method.

Including alizarin and indigo there are 921 different dyes in the world's markets, and these belong to 17 different chemical classes. It is a great industry and a one-nation industry practically. Now that we are cut off from the source by the war, the questions arise, can we and will we develop a dye industry of our own? We have the capital, the enterprise, the material and the chemists who know how. The total world's production amounts to one hundred million dollars, and the investment in the German plants alone amounts to four hundred million dollars. The value of production in Germany is sixty-eight million, in Great Britain six million, in Switzerland six million, in France five million and in the United States less than four million. Our own production in 1913 amounted to 3,300 tons, whereas we imported 25,700 tons. We consume therefore nearly 30,000 tons.

In considering the establishment of a dye industry in this country we must take a look at the possibility of getting a sufficient supply of raw material. When coal is burned in making gas or coke, there is a by-product of tar amounting to about 6 per cent of the coal. When this tar is distilled, we get gases, liquids like benzol, toluol and carbolic acid, solids such as naphthalene and anthracene. Enormous quantities of these materials have gone to waste in this country in part because our great steel industry, the largest in the world, has manufactured its coke in bee-hive ovens. Sixty per cent of the coke was recovered as coke but forty per cent was lost in gases and volatile oils and solids. So-called by-product coke ovens in which the by-products are collected and saved had been introduced in a limited way, but the advent of the great war and the consequent huge demand for ammunition greatly stimulated manufacturers in substituting the by-product for the bee-hive oven. This change is going

on all over the country. The transformation among the mills in the Birmingham district has been very striking and is almost complete. This, of course, means an enormously increased home production of benzol and the other essential raw materials for dye making. At present these compounds are being changed into the high explosives, picric acid and trinitrotoluol for killing men, while some, such as carbolic acid, are being reserved for the purpose of saving men. This reveals to us a matter of paramount importance. In time of war these coal tar products are turned into *explosives,* in time of peace into *dyes.* There can be no doubt that the enormous amount of material used in Germany for making dyes is now going into ammunition. This shuttlecock situation was clearly brought out recently in Congress in a hearing before the Ways and Means Committee of the House of Representatives. The Hill Bill, which proposes an increase in the tariff upon dyes, was under consideration. Manufacturers, dealers and scientists were called to give testimony as to the necessity of providing protection to this infant industry. Mr. Schoellkopf, the head of a large dye manufacturing concern in Buffalo, was asked the question, "If war were declared how soon could your dye factory begin the manufacture of ammunition?" The hearing was taking place on Friday and Mr. Schoellkopf replied, "We could begin next Tuesday." The testimony of others was to the same effect. It is clear, then, how the two operations play into each other's hands. Let us, therefore, construct dye plants now while we are at peace, for the need of them will be even more vital to us in war time.

The question of capital is another point which must be considered in establishing a new industry. Capital goes where it can see a profit. In certain limited directions the manufacture of dyes is already under way. The making of black sulfur dyes is already an industry of importance. Soon after the beginning of the war a large Buffalo concern was earnestly beseeched to greatly enlarge its production of dyes for the textile manufacturers were face to face with the necessity of closing down their mills. An agreement was entered into by which the Buffalo company was to supply certain dyes for two years at a price four times that prevailing before the war.

This high price furnished sufficient funds to enlarge the plant, so there would be no loss even if the plant were to be closed up at the expiration of the contract. This protection was essential, for it is practically certain that there are great accumulations of stocks in Germany, and our market after the war will be flooded with these stocks at ruinously low prices, and no small industry could withstand such an onslaught. Capital will not expose itself to such risks. A certain development can go on under present conditions owing to the high prices obtainable, but this is a precarious basis on which to build a great industry since prevailing conditions can not last. It will be interesting to state at this point some facts about a single German dye factory, since it gives some hint as to what is involved in starting a new industry. This plant consumes daily one thousand tons of coal, forty tons of ice, forty million gallons of water, and two and one-half million cubic feet of gas. The factory site covers five hundred acres of which one hundred acres are covered by several hundred buildings among which are forty-two miles of railway track for transporting material about the plant. Power generation and transmission require 158 boilers, 368 steam engines and 472 electric motors, while 400 telephones are in use. B. C. Hesse is authority for this statement.

The wage question has an important bearing upon the answer which shall be given to our queries. The average daily wage at the largest German dye factory, the Badische Company, was 2.71 marks, or about 65 cents in 1886, whereas it was 4.8 marks or about $1.15 in 1908. That is the daily wage increased from 100 to 177, or nearly double. As American wages are higher than European, this change is working to our advantage. We are unable to predict, however, what conditions will prevail after the war, though it seems reasonable to suppose that higher wages will be the rule.

Another consideration is that of skilled labor and the expert service of chemists. I am unable to see any serious obstacle here. The American Chemical Society, with its 8,000 members, is the largest chemical society in the world. There are many chemical laboratories in this country which can not be surpassed in Europe, not even in Germany where development has been of the highest. Our labora-

tories do not at all confine themselves to elementary instruction. The spirit of research prevails from Hell Gate to the Golden Gate, from the Canadian boundary to the Mexican border. We have chemical journals of the highest standing, and it is idle to suppose that our chemists can not insure the success of the commercial production of dyestuffs.

It is true that we have manufactured some important coal tar dyes such as magenta and naphthol yellow S and were forced to quit on account of European competition. The European plants have been organized so long that they occupy a powerful position for several reasons. In the first place their plants have long been paid for, since the average annual dividends of the twenty-one coal tar dye corporations have been 21.74 per cent. Their elaborate sales organization is thoroughly established in thirty-three other countries, and is able to meet competition with a rapidity and effectiveness that is astonishing. Their gradual development has enabled them to find a profitable use for their numerous by-products, either through sale to other chemical industries or through application to the development of a new dye in their own plants. These advantages are most powerful, and it will take a long war or else some adequate help from the American Congress to found here a permanent industry.

THE SHRUBS AND VINES OF CHAPEL HILL

By W. C. Coker and H. R. Totten

KEY TO THE SHRUBS

I. Leaves compound, alternate on the twig.
  1. Stems with prickles.
    a. Leaflets 3-5, all near the end of the leaf-stalk.
      Stems with bluish-white coating (glaucous)............. *Raspberry* (25)
      Stems not glaucous, trailing.......................... *Dewberry* (26)
      Stems not glaucous or trailing.
        Leaflets greenish on both sides............ *High Bush Blackberry* (27)
        Leaflets white velvety below.................. *Sand Blackberry* (28)
    b. Leaflets 5-9, scattered along most of the leaf-stalk, toothed.
      Growing in wet places, tall........................ *Swamp Rose* (29)
      Growing in dry uplands, short...................... *Pasture Rose* (30)
    c. Leaflets 9-15, along most of the leaf-stalk, not toothed.... *Dwarf Locust* (31)
  2. Stems without prickles.
    Leaflets 3 .... *Poison Oak* (34)
    Leaflets many.
      Branches downy .... *Winged Sumach* (33)
      Branches smooth .... *Smooth Sumach* (32)

II. Leaves compound, opposite on the twig.
  Leaflets 3, near the end of the stalk........................ *Bladder-nut* (40)
  Leaflets 5, at the end of the stalk.............................. *Buckeye* (41)
  Leaflets 5-11, along most of the stalk.............................. *Elder* (69)

III. Leaves compound, clustered at the ends of the slender
  stems; wood yellow .... *Yellow-root* (10)

IV. Leaves simple, alternate on the twig.
  A. Edges of leaves not toothed or lobed (see also B).
    1. Leaves evergreen.
      Leaves long, narrow; stem jointed.................. *Small Cane* (1)
      Leaf blade less than 3 inches long.............. *Mountain Laurel* (49)
      Leaf blade more than 3 inches long............... *Rhododendron* (48)
    2. Leaves not evergreen.
      Leaves broadest near the base (some may have
        coarse teeth) .... *Shrubby Hackberry* (7)
      Leaves broadest near the outer end.
        Odor offensive when bruised.
          A small shrub of upland woods.............. *Upland Pawpaw* (13)
          A tall shrub or small tree of swamps................ *Pawpaw* (12)
        Odor not offensive...................... *Dwarf Huckleberry* (55)
      Leaves broadest near the middle.
        Odor spicy when bruised.......................... *Spice Bush* (14)
        Odor not spicy.
          Fruit a succulent berry.
            Leaves resinous dotted when young;
              branches gray; fruit blue............ *Blue Huckleberry* (56)
            Leaves not resinous dotted; branches reddish.
              Berries blue; leaves tomentose.... *High-bush Huckleberry* (57)
              Berries black; leaves smooth or
                tomentose .... *Black High-bush Huckleberry* (58)
              Berries whitish or pinkish; leaves
                smooth .... *Squaw Huckleberry* (54)
          Fruit a dry pod .... *Stagger-bush* (52)

B. Edges of leaves very obscurely or sparingly toothed or lobed.

1. Blade of leaf about as broad as long, white velvety beneath .... *Large-leaved Storax* (64)
2. Blade of leaf about twice as long as broad.
   - Leaves evergreen; plants small.
     - Aromatic when crushed .... *Wintergreen* (54)
     - Not aromatic .... *Trailing Arbutus* (53)
   - Leaves not evergreen.
     - Leaves with hairy margins; fruit a rather long, dry pod .... *Pink Azalea* (47)
     - Leaves with minute teeth; fruit a globose, dry pod .... *Privet Andromeda* (51)
     - Leaves broadest near the outer end; fruit a many-seeded black berry .... *Sparkleberry* (57)
     - Leaves broadest near the middle; fruit a many-seeded blue berry .... *Low Blueberry* (60)
     - Leaves broadest near the base; fruit a one-seeded berry .... *Shrubby Hackberry* (7)
3. Blade of leaf about three times as long as broad or longer.
   - Leaves small; fruit a black berry.............. *Black Huckleberry* (59)
   - Leaves over two inches long, edges undulate........ *Prairie Willow* (2)
   - Leaves over two inches long, thick, sweet, often evergreen .... *Horse Sugar* (63)

C. Edges of leaves plainly with teeth or lobes.

1. Branches thorny.
   - Leaves toothed but not lobed........................ *Dwarf Thorn* (22)
   - Leaves deeply lobed and toothed.................... *Parsley Haw* (23)
2. Branches not thorny.
   - Leaves with straight parallel veins from the midrib to the edge.
     - Edges of leaves coarsely undulate; fruit a blunt pod with two seeds .... *Witch-hazel* (17)
     - Edges of leaves coarsely undulate; fruit a two-beaked pod with two seeds .... *Fothergilla* (18)
     - Edges of leaves jagged toothed; fruit a nut protected by two leaf-like bracts .... *Hazelnut* (4)
     - Edges of leaves jagged toothed; fruit a nut, the covering extending out as a long beak.......... *Beaked Hazelnut* (5)
     - Edges of leaves finely toothed, sometimes jagged; fruit cone shaped .... *Alder* (6)
   - Leaves with three prominent veins from the base; root red .... *New Jersey Tea* (42)
   - Leaves not as above.
     - Leaves long and narrow, whitish-silky beneath...... *Silky Willow* (3)
     - Leaves narrow, teeth small, regular; fruit large, one-seeded .... *Chickasaw Plum* (24)
     - Leaves elliptic, narrowed at both ends, teeth small and regular, velvety or smooth beneath; fruit an astringent red berry .... *Chokeberry* (19)
     - Leaves ovate, tapering to a point, teeth regular, bronze when young, smooth beneath at maturity; fruit an edible red berry........................ *Shad-bush* (21)
     - As above, but leaves tomentose at maturity and not bronze; fruit hardly edible .... *Swamp Shad-bush* (20)
     - Leaves obovate lanceolate, usually less than an inch broad; fruit small, red, less than one-quarter inch thick, with ridged seeds..................... *Deciduous Holly* (35)
     - Leaves more than 1¼ inches broad; fruit a red berry with ridged seeds .... *Mountain Holly* (36)

Leaves less than $1\frac{1}{4}$ inches broad, tapering to a point; fruit a red berry with smooth seeds........*Winterberry* (37)
Leaves ovate, tapering to a point, teeth coarse or absent; fruit a one-seeded berry ....*Shrubby Hackberry* (7)
Leaves elliptic, tapering at both ends, sweet, sometimes not toothed, sometimes evergreen...........*Horse-sugar* (62)
Leaves elliptic, tapering at both ends; fruit a dry, globose pod with a long beak...............*Swamp Leucothoe* (50)
Leaves elliptic, tapering at both ends; fruit a twin-looking cylindrical pod with a short beak.....*Virginia Willow* (16)

V. Leaves simple, opposite on the twig.

A. Edges of the leaves not toothed or lobed.

1. Leaves small, under two inches long.
Leaves with translucent dots.*
Fruit not protected by bracts..................*St. John's Wort* (45)
Fruit protected by bracts.
Leaves about one-quarter inch wide........*St. Andrew's Cross* (43)
Leaves about one-half inch wide.............*St. Peter's Wort* (44)
Leaves without dots.
Evergreen, parasitic ....*Mistletoe* (9)
Not evergreen.
Leaves and stems tomentose.................*Indian Currant* (66)
Leaves and stems not tomentose...................*Nestronia* (8)

2. Leaves over two inches long.
Evergreen, some alternate ....*Mountain Laurel* (49)
Not evergreen.
Leaves spicy when crushed......................*Sweet Shrub* (11)
Not spicy.
Branches reddish ....*Swamp Dogwood* (46)
Branches not reddish ....*Button-bush* (65)

B. Edges of the leaves with teeth or lobes.
Leaves with three lobes......................*Maple-leaved Arrow-wood* (67)
Leaves toothed but not lobed.
Branches green; fruit warty.......................*Strawberry Bush* (38)
Branches green; fruit not warty.....................*Burning Bush* (39)
Branches not green.
Leaves smooth ....*Wild Hydrangea* (15)
Leaves downy ....*Downy-leaved Arrow-wood* (68)

1. *Arundinaria tecta* (Walt.) Muhl. Small Cane.

A small reed or bamboo that is abundant along large streams, as New Hope Creek, and reaching a height of 10-12 feet, often only 2.5-3 feet high when ascending banks. We have no record of its ever fruiting in this section.

2. *Salix humilis* Marsh. Prairie Willow.

A small spreading bush, usually about waist high, with narrow leaves, the edges rolled under and undulate or, on strong shoots, sometimes toothed, green above, smooth and glaucous or rusty tomentose below; growing in damp places or in damp woods as in the pines northwest of Piney Prospect. Not abundant, but often met with in low places along roads. Dates of flowering: March 21, 1915; February 23, 1916.

*Apparent when held to the light.

3. *Salix sericea* Marsh. Silky Willow.

A large spreading shrub ten or twelve feet high, common along the streams where its dark green foliage stands out in contrast to the light, delicate green of the more tree-like Black Willow; edges of leaves finely toothed and the under side covered with minute, whitish, silky hairs. Dates of flowering: March 16, 1903; March 30, 1909; March 8, 1910; April 5, 1915.

4. *Corylus americana* Walt. Hazelnut.

A shrub about six feet high, growing in or near the low grounds, as around Scott's Hole and at base of Lone Pine Hill; leaves broad, heart-shaped, and pointed, edges wavy or jagged and many toothed, hairy; fruit an edible nut covered by two leaf-like bracts. Dates of flowering: February 28, 1909; Februrary 23, 1910; March 10, 1912; February 5, 1914; February 15, 1915; January 26, 1916.

5. *Corylus rostrata* Ait. Beaked Hazelnut.

A much smaller plant than the above growing on hillsides, as on Laurel Hill and Lone Pine Hill; leaves smaller and less heart shaped than in the above; the very hairy bracts extending beyond the nut as a long beak, but very little fruit is set in this section. Dates of flowering: March 7, 1910; March 23, 1916.

6. *Alnus rugosa* (Du Roi) Spreng. Alder.

A large shrub growing along streams and damp meadows, with dark green foliage and dark bark; leaves ovate-elliptic, pointed at both ends, toothed; fruits small and cone-like, often made abnormal by the attack of a fungus (*Exobasidium alni*). Dates of flowering: February 20, 1908; January 25, 1909; February 17, 1910; March 10, 1912; February 2, 1914; February 13, 1915; January 26, 1916.

7. *Celtis georgiana* Small. Shrubby Hackberry.

A shrub of dry and mostly rocky hillsides and bluffs, as on Mount Bolus and on the rocks opposite Laurel Hill. Leaves ovate, tapering to a point, edges either entire or toothed; fruit a small tan to black, sweetish, berry that is mostly stone. Dates of flowering: April 17, 1903; April 23, 1915; April 26, 1916.

8. *Nestronia umbellula* Raf. Nestronia.

A low dioescious shrub, parasitic on the roots of trees. It is rare here, but has been found along the sandy bank of Morgan's Creek; leaves ovate, with entire edges; flowers greenish, small, borne on short pedicels at the tip of a rather long peduncle; fruit about half an inch in diameter, but is not found here as our plants are all males and bear no fruits. Date of flowering: May 1, 1909.

9. *Phoradendron flavescens* (Pursh) Nutt. Mistletoe.

This well-known plant is parasitic on most species of trees. It is common here, but is not so abundant as farther east.

10. *Xanthorrhiza apiifolia* L'Her. Yellow-root.

A low shrub with long stalked, compound leaves clustered at the ends of the slender, little-branched stems; flowers small, brownish-purple,

borne in compound racemes; wood and roots yellow. Growing mostly on margins of larger streams, as along Morgan's Creek, and at "The Caves" on New Hope Creek. Dates of flowering: March 16, 1903; March 16, 1908; March 28, 1909; March 28, 1910; April 5, 1915; March 24, 1916.

11. *Calycanthus fertilis* Walt. Sweet-shrub.

A shrub much branched at the ground, and increasing by underground runners; twigs reddish-brown, spicy; leaves ovate elliptic; flowers brownish-purple, fragrant, at the ends of short leafy shoots; fruits large and rough, something like a rose hip in shape, but larger. Rare here, but has been found in the woods back of Mr. H. H. Patterson's home, and near Carrboro.

12. *Asimina triloba* (L.) Dunal. Pawpaw.

A tall slender shrub or small tree that is common along streams and sometimes reaches a height of about 15 feet and a diameter of 2½ inches; leaves large, smooth, bad smelling; flowers dull purplish; fruits greenish or brownish, shaped like a short banana, edible. Dates of flowering: April 11, 1903; May 7, 1909; April 12, 1910; April 8, 1913; April 16, 1916.

13. *Asimina parviflora* (Michx.) Dunal. Upland Pawpaw.

A low shrub growing in upland woods, as north of the cemetery, and near Battle's Branch; leaves obovate, with a small mucronate point, thin, bad smelling when bruised. Young twigs red-hairy; flowers dark brownish purple. It is much like the above only smaller in every part, and the fruits are more knotty. Date of flowering: April 8, 1903.

14. *Benzoin æstivale* (L.) Nees. Spice-bush.

A large shrub with many long, smooth, greenish shoots of a spicy taste and odor; leaves ovate to elliptic, pointed at both ends, aromatic; fruit a small red berry-like drupe with an aromatic principle which is used in medicine. Common along the branches. Dates of flowering: March 15, 1903; March 14, 1908; February 25, 1909; March 16, 1910; March 24, 1912; April 5, 1915; March 21, 1916.

15. *Hydrangea arborescens* L. Wild Hydrangea.

Not at all common here, but found in cool, damp woods as at "The Caves," on New Hope Creek, and on the south bank of Morgan's Creek, above Davis' Ford. Leaves ovate to elliptic, pointed, prominently and evenly toothed; small flowers in large, broad clusters at the ends of the branches; outer bark on older parts of the plant thin and loose.

16. *Itea virginica* L. Virginia Willow.

A slender shrub about 3-5 feet high, with oval, pointed, finely toothed leaves; flowers small, white, fragrant, grouped along the ends of the branches in spike like clusters; fruit a small twin pod with a common beak. Here and there along branches in woods, not common. Dates of of flowering: May 18, 1903; May 17, 1908; May 15, 1909; May 6, 1910; May 9, 1913; May 18, 1915; May 21, 1916.

17. *Hamamelis virginiana* L. Witch-hazel.

A large shrub growing along the branches and on cool northern bluffs,

as Laurel Hill; leaves oval to elliptic, with a wavy edge, barely toothed; flowers yellowish, with long slender petals, appearing in fall; fruit a scurfy, blunt pod containing two polished seeds, ripens in summer. Date of flowering: November 9, 1913.

18. *Fothergilla major* Lodd. Fothergilla.

Related to the Witch-hazel, but smaller; leaves much like those of the Witch-hazel; flowers white, borne in a short dense spike, the color coming from the numerous conspicuous stamens which are white and enlarged upwards; pods hairy, with two long-pointed beaks. Grows on cool bluffs, facing north, as at Laurel Hill and The Caves. Dates of flowering: May 14, 1912; May 2, 1915.

19. *Pyrus arbutifolia* (L.) L. f. Chokeberry.

A small slender thornless shrub that is not rare in wet soil, as in the low woods west of the cemetery; leaves elliptic, toothed, remarkable in the variation shown on the under side, which may be quite smooth and shining or densely woolly tomentose; flowers small, white, borne in clusters; fruit red, small, shaped like a quince, very astringent. Dates of flowering: March 27, 1903; March 28, 1908; March 15, 1909; March 30, 1910; April 21, 1915.

20. *Amelanchier Botryapium* (L. f.) DC. Swamp Shad-bush.

A slender shrub or small tree growing usually in the low grounds, and rare at Chapel Hill. Leaves obovate, with us usually slightly cordate at base, apex acute, margin with numerous, small close-set, acute teeth, lower surface densly white-tomentose until maturity or later, whitish green when young, not purplish. Flowers in nodding racemes, usually about 6-12, both peduncles and pedicles closely pubescent, calyx lobes pubescent, reflexed at base when the petals fall, broad and abruptly long pointed; petals white, oblong. Fruit purplish red, scarcely edible, often diseased by the attack of a fungus. There is much confusion as to the correct name for this tree. In Britton's trees it is called A. *intermedia* Spach.; in Gray's Manual, 7th ed., *A. canadensis*, var. *Botryapium;* and Wiegand (Bull T. B. C. *14*: 150. 1912) calls it *A. canadensis.*

21. *Amelanchier canadensis* (L.) Medic. (A. *lævis* Wiegand) Shad-bush, Service-berry.

A shrub or small tree, much like the preceding but distinguished by the leaves being purplish brown until full maturity, and by the much more scanty pubescence on the leaves and inflorescence. By maturity the leaves are nearly or quite glabrous, but in youth there are hairs on both surfaces, the difference between our two species in this respect being only a matter of degree. Calyx lobes narrower and more lanceolate than in in the above, and the fruits more abundant and of better quality. Dates of flowering: March 8, 1903; March 15, 1908; March 1, 1909; March 23, 1910; March 26, 1912; March 23, 1916. The time of flowering differs considerably in different plants. In 1916 some were in bloom March 23, others not until April 17th. This is a rather common plant of dry woods, hillsides and creek bluffs and banks, usually a shrub but reaching at times in Chapel Hill a height of 20 feet and a diameter of 6 inches. A

tree of this size stands on the south bank of Bowlin's Creek about 100 yards northwest of the cow barn on Glenn Burnie Farm. The fruit was fully ripe on this tree on May 28, 1916.

22. *Crataegus uniflora* Muench. Dwarf Thorn. Red Haw. Rabbit Apple.

A thorny plant with small obovate to elliptic, shining leaves, the broad end toothed, leaf stalks very short; twigs fuzzy when young; flowers usually single, not clustered as in most haws, sometimes 2 or 3 together; fruit yellowish or reddish with large, deeply-toothed calyx lobes, edible. Not rare in dry open woods, along roads, etc. Dates of flowering: April 28, 1903; April 23, 1908; May 2, 1909; May 8, 1916.

23. *Crataegus Marshallii* Eggl. (*C. apiifolia* Michx.) Parsley Haw.

Leaves broadly ovate or orbicular, ¾-1½ inches in diameter, jagged toothed, and with 5-7 deep narrow clefts, leaves and twigs softly tomentose when young, the upper side of the leaves usually becoming smooth and shiny green; flowers in clusters of 10-12; fruit oblong, ¼ inch long, bright red. The Parsley Haw is found rather plentifully along the borders of low grounds, in low flat woods and in upland woods, and its delicate foliage and compact sturdy habit make it our most ornamental haw in cultivation. Occasionally this is a small tree, but with us it is almost always a shrub. In full flower April 30, 1916.

24. *Prunus angustifolia* Marsh. Chickasaw Plum.

This is the common shrub that forms the plum thickets on edges of fields and in waste places throughout most of the State. According to an old Indian tradition it was brought from beyond the Mississippi. Leaves narrow, 1-2 inches long, ⅓-⅔ inch wide, teeth very fine and close; fruits reddish or yellowish, about ½ inch in diameter, sweet and edible, borne in umbels. Dates of flowering: about March 10, 1903; March 15, 1908; February 16, 1909; March 20, 1910; March 25, 1912; March 14, 1915; March 5, 1916.

25. *Rubus occidentalis* L. Raspberry.

A brier with smooth glaucous stems, found occasionally along the edges of clearings, etc.; stems recurving and rooting at the tips; fruit purple black, falling from the dome-shaped receptacle when ripe. Date of flowering: April 15, 1903.

26. *Rubus procumbens* Muhl. Dewberry.

A trailing brier of old fields, etc., and often forming extensive mats in damp open places; prickles weak, stems rooting at the tips; fruit globose with large black druplets, ripening early. Dates of flowering: April 4, 1903; April 15, 1908; April 12, 1909; April 8, 1910; April 19, 1916.

27. *Rubus Andrewsianus* Bl'd. Southern High-Bush Blackberry.

The common large blackberry of old fields, low grounds, etc.; branches deeply grooved, prickles stout, straight or bent; leaflets greenish on both sides; fruit cylindric with many black druplets. Dates of flowering: April 12, 1903; April 20, 1908; April 27, 1909; April 16, 1910.

28. *Rubus cuneifolius* Pursh. Sand Blackberry.

A low brier with many strong prickles; leaflets thick, deep green

above, white-velvety below; fruits medium sized, of good flavor, ripening later than the other species, one form ripening as late as August and 1st of September. This species is confined to dry, sandy soil as in open woods southwest of Dr. Battle's home. It is not so common as the two preceding.

29. *Rosa carolina* L. Carolina or Swamp Rose.

The tall wild rose of wet soil as at base of Lone Pine Hill; stem with a few stout, usually bent prickles; leaflets finely toothed; flowers pink. Date of flowering: June 16, 1915.

30. *Rosa humilis* Marsh. Pasture Rose.*

The wild rose of dry soil, as in Battle's Park near the University gate; stem low, with many slender straight prickles; leaflets coarsely toothed. Dates of flowering: May 25, 1909; May 14, 1910; May 2, 1915; May 25, 1916.

31. *Robinia nana.* (Ell.) Spach. Dwarf Locust.

A rare low shrub, the stem with or without prickles; peduncles and pedicels glandular bristly; leaves and stems slightly soft-hairy or smooth; leaves compound with 9-15 leaflets, flowers large, purplish pink, pea-like; fruit a flat, slightly hairy pod. Occasional on well drained banks, as along the old Raleigh road north of Piney Prospect. Dates of flowering: May 9, 1909; May 4, 1912.

32. *Rhus glabra* L. Smooth Sumach.

A smooth shrub with large compound leaves, the leaflets toothed, white beneath; fruits small, scarlet, berry-like, with an acid taste, in large clusters at the top of the plant; pith large; stems sprouting freely from the long runner-like roots. Rather common in dry open places. Date of flowering: June 18, 1915.

33. *Rhus copallina* L. Winged Sumach.

Differs from the smooth sumach in that the stems are smaller, more woody, downy and warty; the leaflets usually are not toothed, and the leaf stalks are winged between the leaflets. Rather common along ditches, in open woods, etc. Date of flowering: July 20, 1916.

34. *Rhus toxicodendron* L. Poison Oak.

A low, slender shrub, usually consisting of a single, upright stem about 1-2 feet high, with the leaves and flowers clustered at the top; leaves compound, leaflets three, more or less lobed; flowers greenish yellow, in apical clusters; fruit a small, whitish berry. Very poisonous to most people. Common in dry woods. Dates of flowering: May 3, 1903; May 3, 1909; May 2, 1910; May 7, 1916.

35. *Ilex decidua* Walt. Deciduous Holly.

A tall dioecious shrub or small tree that is common in low woods and not rare on hillsides and flat upland woods. Leaves usually small, less than an inch wide and 2.5 inches long, obovate-oblong; berries red, smaller than in the two following, less than $\frac{1}{4}$ inch thick, and on longer

*No attempt is made to classify the cultivated roses that are sometimes found escaped in open places and around old trash piles. We have not found the sweet brier (*Rosa rubiginosa*).

stalks, the nutlets with longitudinal ridges; an attractive winter berry. Dates of flowering: April 14, 1903; April 19, 1908; April 13, 1910; April 27, 1916.

36. *Ilex monticola* Gray. Mountain Holly.

A large dioecious shrub of the upland woods and open hillsides, as at top of Lone Pine Hill; not abundant; leaves ovate-lanceolate, broad, long pointed, acute or obtuse at the base, finely toothed; fruit a small, red, berry (drupe), the nutlets with longitudinal ridges. Dates of flowering: May 8, 1903; May 12, 1909; May 5, 1910; May 10, 1913; May 29, 1915; May 17, 1916.

37. *Ilex verticillata* (L.) Gray. Winter-berry.

This differs from the large-leaved Holly in that it grows in low, damp woods, as at base of Lone Pine Hill, and the nutlets are smooth; the leaves are apt to be smaller, narrower, and coarser toothed. Not plentiful. Dates of flowering: May 29, 1909; May 25, 1910; May 29, 1915; May 29, 1916.

38. *Euonymus americanus* L. Strawberry bush.

A very common shrub with green stems, narrow, opposite, finely toothed leaves on short leaf-stalks; pods red and warted; seeds surrounded by a bright red, meaty covering, hanging out of the pod when ripe. Our wild plants are now being badly attacked and many are killed by the Euonymus scale, introduced into this counrty on the Japanese Euonymus. Dates of flowering: April 21, 1903; April 23, 1908; April 25, 1909; April 15, 1910; April 28, 1913; April 12, 1915; May 12, 1916.

39. *Euonymus atropurpureus* Jacq. Burning Bush.

A larger shrub than the above with larger leaves and moderately long leaf-stalks; fruits smooth, bright red, curiously lobed, hanging on long peduncles; seeds surrounded by a bright red, meaty covering. Date of flowering: about April 21, 1903. This is one of the rarest plants in the State and has been found here only on the sandy bank of Morgan's Creek at Scott's Hole.

40. *Staphylea trifolia* L. Bladder-nut.

A large shrub with compound leaves, the three leaflets ovate, pointed and finely toothed; fruit a large bladdery pod. Not uncommon along large streams, as at Scott's Hole. Dates of flowering: April 17, 1903; April 10, 1909; April 16, 1916.

41. *Aesculus octandra* Marsh. Buckeye.

Common as a shrub, sometimes found as a small tree, as at Lone Pine Spring; leaflets five, at the tip of a long leaf-stalk; flowers yellow, most of them with rudimentary ovaries; fruits smooth, brown, containing large, dark-brown, polished seeds. We have found two plants of this with red flowers near the pumping station where the typical form is abundant. Dates of flowering: March 27, 1903; April 3, 1908; April 25, 1909; April 3, 1910; April 23, 1915; April 14, 1916.

42. *Ceanothus americanus* L. New Jersey Tea.

Plant forming a low, broad clump of small, much branched stems with

ovate, pointed, toothed, three ribbed leaves; flowers small, white or flesh-pink, clustered on stalks that project above the leaves. Very common in dry woods and on rocky hills. Dates of flowering: May 23, 1903; May 14, 1908; May 15, 1909; May 26, 1910; May 29, 1915; May 29, 1916.

43. *Ascyrum hypericoides* L. St. Andrew's Cross.

Low, partly decumbent, almost herb-like plants with small, narrow, obovate, opposite leaves and yellow flowers with a pair of small sepals and a pair of large sepals that persist and enclose the small, dry, many seeded fruit. Very common, partially evergreen. Date of flowering: About June 30, 1916.

44. *Ascyrum stans* Michx. St. Peter's Wort.

More erect, all parts of the plant larger, and leaves much broader. Not common, and has been found here only in the damp soil near Handcock's bridge on Bowlin's Creek and on Mason's farm.

45. *Hypericum nudiflorum* Michx. St. John's Wort.

General appearance like St. Peter's Wort, but there are five short sepals instead of four long ones and they do not enclose the fruit. Found in wet soil and sandy soil along the creeks as in the meadow below Lone Pine Hill and on the sandy bank of Morgan's Creek at Scott's Hole. Flowers about the end of June.

46. *Cornus amomum* Mill. Swamp Dogwood.

A large shrub with reddish-brown branches, small white flowers in broad bunches, and small bluish berries. Common along streams. Dates of flowering: May 30, 1909; May 20, 1910; May 20, 1913; May 28, 1915; May 20, 1916.

47. *Azalea nudiflora* L. Pink Azalea or Wild Honeysuckle.

A shrub of medium size, common through the woods and along branches; flowers pink, in conspicuous clusters, appearing before or with the leaves; leaves oval, hairy at least on the margin; fruits dry, hairy, persisting through the winter. Dates of flowering: March 26, 1903; April 2, 1908; April 7, 1909; April 4, 1910; April 21, 1915; April 13, 1916.

48. *Rhododendron catawbiense* Michx. Purple Rhododendron.

A large shrub found on the rocky bluffs along Morgan's and New Hope Creeks, as at Laurel Hill and The Caves; leaves broadly elliptic, thick, evergreen; flowers large, purplish pink. Dates of flowering: April 11, 1903; April 20, 1908; April 25, 1909; April 12, 1910; May 7, 1916. The Purple Rhododendron is supposed to grow only on the mountains, but is abundant here in places and we have found it as far east as Selma, in the middle coastal plain.

49. *Kalmia latifolia* L. Mountain Laurel.

A large, evergreen shrub found with the Rhododendron; with smaller, taper-pointed leaves and saucer-shaped pink or white flowers, with curious pockets for the anthers. The leaves are poisonous to men and animals and are said to have been used at times by the Indians to commit suicide. Dates of flowering: May 10, 1903; May 10, 1909; May 16, 1910; May 11, 1915; May 14, 1916.

50. *Leucothoe racemosa* (L.) Gray. Swamp Leucothoe.

Plant about three feet high. Leaves ovate, pointed, toothed; flowers small, cylindric, white, in long racemes at the ends of the branches; fruit small, globose, dry, with the style persisting as a long beak, sepals as long or longer than the fruit and also persisting. Rare but occasionally found in wet soils in low grounds, as on the Mason Place.

51. *Lyonia ligustrina* (L.) DC. Privet Andromeda.

Similar to the Swamp Leucothoe, but the leaves are only minutely toothed; flowers white, globose, styles not persisting, and sepals shorter than the globose fruit. Rather common in poorly drained soil in flat woods, as near the east gate of the campus, and near springs and branches. Dates of flowering: May 20, 1903; May 18, 1909.

52. *Lyonia mariana* (L.) D.Don. Stagger-bush.

Smaller than the last two; the leaves not at all toothed and the cylindric flowers larger and grouped in alternate umbels along leafless stems; fruit short, cylindric, and contracted toward the top. Not rare in poorly drained woods, as near the east gate of the campus. Dates of flowering: May 3, 1903; May 3, 1909; May 2, 1910; May 6, 1916.

53. *Epigaea repens* L. Trailing Arbutus.

A small trailing plant with hairy stems, hairy, oval, evergreen leaves, and small, white to pink, sweet-scented flowers. Plentiful on shady, rocky bluffs facing north, with Rhododendron and Kalmia; rarely on bluffs facing south. Strange to say, it does not occur here except near the largest streams (Morgan and New Hope Creeks), and is not found in most of our rich woods even in the most favorable situations. Dates of flowering: March 15, 1903; March 15, 1908; March 7, 1909; March 18, 1910; March 27, 1912; March 23, 1916.

54. *Gaultheria procumbens* L. Wintergreen.

An erect little plant, with short, wiry, upright, branches from a creeping stem; leaves smooth, ovate, evergreen, the edges turned under and slightly toothed; flowers small, white, cylindric; berries red. The leaves and berries have the well known spicy odor of wintergreen. Found here only at The Caves, on rocky bluffs of New Hope Creek.

55. *Galussacia dumosa* (Andre.) T. & G. Dwarf Huckleberry.

Our smallest huckleberry, the slender, upright, little-branched stem about 5-7 inches high; leaves shiny, ovate to elliptic, with an abrupt point and turned-under edges, green on both sides; flowers small, pinkish white, with a rather large persisting bract at the base of each flower stalk; fruits black, large, glandular-bristly, edible, ripening in July. Found in dry mixed woods as east and northwest of the cemetery and on Rocky Ridge Farm; not plentiful. Dates of flowering: May 3, 1909; May 10, 1914.

56. *Galussacia baccata* var. *glaucocarpa* (Robinson) Mackenzie. Blue Huckleberry.

Plant about two feet high, leaves similar to those of the above, but without the abrupt point and with resinous globules when young; the

bract smaller and not persisting; fruits blue, with a bloom, ripening in July; edible. This is a mountain plant that has been found here only on Laurel Hill.

57. *Vaccinium arboreum* Marsh. Sparkleberry.

A shrub on the uplands or a small tree on the sandy banks and rocky bluffs along the creeks; leaf small, obvate, thick, shiny, with very minute points on the turned-under edges and a small point at the end; flower small, white, short and broad, anthers included; berries small, black, dryish, ripening in the fall and hanging on through the winter; scarcely edible. Date of flowering: May 23, 1909.

58. *Vaccinium stamineum* L. Squaw Huckleberry, Wild Gooseberry.

A medium sized shrub with reddish twigs common in dry woods; leaves elliptic or ovate, thin, not shining; flowers greenish white, short and broad, stamens longer than the petals; fruits large, whitish or pink, ripening in July, bitter and usually considered inedible, but liked by some. Our plant is the form with quite smooth leaves that are usually glaucous below, that Small has described as *V. neglectum.* Dates of flowering: April 5, 1903; April 20, 1908; April 21, 1909; April 23, 1915; May 4, 1916.

59. *Vaccinium tenellum* Ait. Black Huckleberry.

A low shrub common in dry woods, with slender, greenish, pubescent branches; leaves thin, narrow, obovate, with minutely toothed edges and a small point at the end; flowers white, narrow, cylindric; berry black with a whitish overcolor (with a "bloom"); edible. Dates of flowering: March 21, 1903; April 23, 1915; April 11, 1916.

60. *Vaccinium vacillans* Kalm. Low Blueberry.

A common, small shrub, about the size of the Black Huckleberry and often growing with it, but the greenish branches are not pubescent, the leaves are broader, and the small sweet berries are blue; edible. Dates of flowering: April 1, 1903; April 2, 1908; April 22, 1915; April 12, 1916.

61. *Vaccinium corymbosum* L. High-bush Huckleberry.

A large shrub of wet soil, with reddish twigs and ovate to elliptic, pointed leaves without teeth; twigs and leaves pubescent or smooth; flowers white or pink, cylindric; berries dark-blue, with a bloom; edible. Dates of flowering: March 15, 1903; March 30, 1908; March 11, 1909; April 16, 1915; March 27, 1916.

62. *Vaccinium fuscatum* Ait. Smooth Form (*V. australe* Small.) Black High-bush Huckleberry.

This species of Huckleberry has not been reported before from North Carolina, and is given in Small's Flora as occurring from Georgia to Florida, and westward. We have found it to be plentiful at Hartsville, S. C., and near the grave of Thomas Walter on the Santee River, so that it probably extends over most of the coastal plain in that State at least. Our Chapel Hill plant is quite smooth, and is the form that Small has named *V. australe*, while the typical form of *V. fuscatum* is described as tomentose. However, both at Hartsville and on the Santee River, the species varies to almost or quite smooth leaves, and as in other respects

the forms seem identical, we think it best to include the smooth form in *V. fuscatum*. The species is nearest *V. corymbosum*, with the same height and habitat, but is easily distinguished by the much smaller flowers and the shiny-black, smaller berries that ripen earlier. We have so far found it only in wet, flat woods near the Mason Farm.

63. *Symplocos tinctoria* (L.) L'Her. Horse-Sugar.

A large, partially evergreen shrub, with light gray bark on old stems and reddish-gray twigs; leaves thick, long-ovate, pointed, with slightly toothed edges and sweet taste; flowers small, light yellow, fragrant, borne in bunches along the twigs; fruit small, dry, cylindric, containing one seed. Found here only at The Caves on New Hope Creek.

64. *Styrax grandifolia* Ait. Large-leaved Storax.

A fine large shrub with smooth and very dark bark, and broad ovate to obovate leaves with minute distant teeth, white velvety below; flowers white, fragrant; fruits hard, dry, globose. Found near branches and on hillsides, etc.; plentiful in woods south and east of Meeting of the Waters. Dates of flowering: April 25, 1903; April 25, 1909; April 19, 1910; April 26, 1913; April 27, 1916.

65. *Cephalanthus occidentalis* L. Button-bush.

A large, rather common shrub of the low grounds, with opposite, ovate, pointed leaves and triangular stipules between; flowers in globose heads, small, white and fragrant, with long protruding styles; fruits in globose heads. Date of flowering: June 24, 1916.

66. *Symphoricarpos orbiculatus* Moench. Indian Currant.

A low shrub with loose, shreddy old bark and purplish new bark beneath; flowers small, pinkish, in the axils of the opposite, ovate, pointed leaves; berries in clusters, purplish red, hanging on through the winter. Found sparingly along old roads, as west of Carrboro. Probably introduced. Date of flowering: July 7, 1916.

67. *Viburnum acerifolium* L. Maple-leaved Arrow-wood.

A rather small, slender shrub with opposite, three lobed, coarsely toothed, maple-like leaves; large clusters of small white flowers, and reddish to purplish berries. Common in cool, rich, well-drained woods, as along Battle's branch. Dates of flowering: May 2, 1903; May 3, 1909; May 6, 1915; May 7, 1916.

68. *Viburnum pubescens* (Ait.) Pursh. Downy-leaved Arrow-wood.

Larger and more robust than the above, and easily distinguished from it by the leaves, which are smaller, ovate, and without lobes; berries black at maturity. Dates of flowering: April 17, 1903; April 19, 1908; April 18, 1909; April 15, 1910; May 6, 1911; April 24, 1913; April 25, 1916.

69. *Sambucus canadensis* L. Elder.

A large shrub with little wood and large pith; leaves opposite, compound; flowers, small and white in large flat clusters; berries small, blackish, juicy, edible when cooked. Common in low grounds and not rare along fences in uplands. Dates of flowering: May 21, 1903; May 19, 1908; May 10, 1909; May 25, 1910; May 29, 1915; May 21, 1916.

KEY TO THE VINES.

I. Tendrils or aerial rootlets present.
  A. Stems with prickles.
    Leaves bluish-white (glaucous) below........*Glaucous-leaved Greenbrier* (2)
    Leaves not bluish-white below.
      Leaves ovate, not bristly on the margin or broadened at base or white dotted ....*Greenbrier* (1)
      Leaves variable, usually some with bristles on margin, or with light dots, or suddenly broadened at the base.*Bristly Greenbrier* (3)
  B. Stems without prickles.
    1. Leaves compound.
      Leaves alternate, leaflets five...................*Virginia Creeper* (8)
      Leaves alternate, leaflets three........................*Poison Ivy* (7)
      Leaves opposite, leaflets two.........................*Cross Vine* (16)
      Leaves opposite, leaflets several.................*Trumpet Creeper* (15)
    2. Leaves simple.
      a. Leaves toothed.
        Bark not shreddy; leaves smooth and shining.*Muscadine Grape* (12)
        Bark shreddy.
          Leaves densely white-velvety below; fruits large ....*Northern Fox Grape* (9)
          Leaves whitish, rusty-velvety below; fruits small, bluish ....*Summer Grape* (10)
          Leaves green and smooth below; fruits very small, black ....*Frost Grape* (11)
      b. Leaves lobed, but not toothed; fruit with a single flattened seed ....*Canada Moonseed* (6)

II. No tendrils or aerial rootlets present.
  1. Leaves compound.
    Leaflets three, not toothed; flowers borne singly..........*Leather Flower* (5)
    Leaflets three, toothed; flowers in clusters........*Virginia Virgin's Bower* (4)
  2. Leaves simple.
    Fruit a long, slender pod; flowers small...............*Climbing Dogbane* (14)
    Fruit a short pod; flowers large, yellow...............*Yellow Jessamine* (13)
    Fruit a black berry; flowers long-tubular, white....*Japanese Honeysuckle* (18)
    Fruit a red berry; flowers long-tubular, red; upper pair of leaves fused together ....*Woodbine* (17)

1. *Smilax rotundifolia* L. Greenbrier or Catbrier.

A common and troublesome, green, woody vine of damp woods, ditch banks, etc., with rigid prickles; leaves ovate, taper pointed, without whitish blotches or basal lobes; fruit a bluish black berry that hangs on through the winter. Dates of flowering: April 8, 1903; April 19, 1909; April 17, 1910; April 26, 1915.

2. *Smilax glauca* Walt. Glaucous-leaved Greenbrier.

Easily distinguished from the other briers in that the leaves have a bluish-white coating on the under side. Common in old fields, along hedge rows, etc.

3. *Smilax Bona-nox* L. Bristly Greenbrier.

Leaves varying in shape from ovate-lanceolate to halberd shaped with two lobes at the base, often with small bristles along the edges and with whitish blotches. Common in old fields, etc. Dates of flowering: May 13, 1903; May 12, 1909.

4. *Clematis virginiana* L. Virginia Virgin's Bower.

A woody vine with opposite compound leaves of three, ovate, toothed leaflets at the end of a long leaf stalk; flowers small, white, clustered; fruits a cluster of small, dry ovaries with long feathery styles; found in damp soil along the creeks, as on the ditch near the south foot of Mt. Bolus; rather rare. Date of flowering: May 15, 1908.

5. *Clematis Viorna* L. Leather Flower.

A smaller and less woody vine than the above; leaves mostly with three leaflets, but some of the leaves may be entire or lobed, not toothed; flowers large, nodding, with thick, brownish sepals, borne singly; fruits similar to the fruits of the Virginia Virgin's Bower. Found along the creeks and in rich, cool woods. Date of flowering: July 11, 1914.

6. *Menispermum canadense* L. Canada Moonseed.

A barely woody vine with large heart shaped, entire, angled, or lobed leaves, on long leaf-stalks which are peltately attached near the edge of the blade; fruits black, bitter, in grape-like clusters; seeds peculiar, flat and moon-shaped or more like the under side of a horse's hoof; roots yellow. Found sparingly along streams. Date of flowering: May 10, 1903.

7. *Rhus radicans* L. Poison Ivy.

Very much like the shrub Poison Oak, but is a woody vine climbing by rootlets; leaves compound, of three lobed leaflets near the end of the leaf stalk; fruits small, whitish, berry-like. Poisonous to most people; common. Dates of flowering: May 8, 1903; May 4, 1909; May 2, 1910; May 11, 1915.

8. *Psedera quinquefolia* (L.) Green. Virginia Creeper.

A woody vine with compound leaves of five, toothed leaflets at the end of the leaf stalk; climbing by tendrils ending in sticking disks and often by rootlets; fruit a small blue berry, borne in clusters. Easily distinguished from the Poison Ivy by the five leaflets. Not rare along margins of fields, as on Glenn Burnie Farm.

9. *Vitis labruska* L. Northern Fox Grape.

A grape with shreddy bark and large, toothed leaves, often lobed, the under side white-velvety; fruits large, sour, but making a fine jelly. Not common with us, but has been found on the hill north of Purefoy's Mill and at the edge of the marshy meadow north of New Hope bridge on the Durham road. This is the parent of many of our best cultivated grapes. It is the first to bloom of all the grapes.

10 *Vitis æstivalis* Michx. Summer Grape.

A much commoner grape, the leaves rusty-velvety below; fruits small, bluish, ripening early and fairly good to eat. It is the parent of several of our cultivated grapes. Dates of flowering: May 21, 1903; May 18, 1908; May 18, 1909; May 3, 1910; May 21, 1915; May 20, 1916.

11. *Vitis cordifolia* Michx. Frost Grape.

A very common grape that is easily distinguished from the above two by the smooth, green under surface of the leaf; fruits very small, black,

sour and astringent, late and not good. Dates of flowering: May 17, 1909; May 3, 1910; May 14, 1915; May 14, 1916.

12. *Vitis rotundifolia* Michx. Muscadine or Bullace Grape.
Bark not shreddy, the small, rounded, toothed leaves shiny on both sides; fruits large, in small clusters, ripening early and very sweet; common in damp or rich woods. Dates of flowering: June 6, 1915; May 28, 1916. The Scuppernong is a descendant of the Muscadine and will bear very little unless pollinated by it.

13. *Gelsemium sempervirens* (L.) Ait. f. Yellow Jessamine.
A strong vine, twining over trees or running along the ground; leaves small, opposite, evergreen; flowers large, fragrant, yellow, followed by small, dry, flattened pods. Some of the flowers are transformed into galls by the eggs of a small beetle, which are laid in the ovaries; such flowers have large corollas, but do not open. Dates of flowering: March 22, 1903; March 19, 1909; March 29, 1910; April 16, 1915; April 2, 1916.

14. *Trachelospermum difforme* (Walt.) Gray. Climbing Dogbane.
A twining vine with small opposite leaves, small yellow flowers, and long slender pods, the narrow seed with a tuft of silky hairs at one end. Occasional in low grounds, as on the Mason Farm and near the Durham road bridge on New Hope Creek. Date of flowering: June 12, 1916.

15. *Tecoma radicans* (L.) Juss. Trumpet Creeper.
A strong vine with large compound leaves with several, toothed leaflets; flowers large, reddish, trumpet shaped; pods large, long, plump. Very common. Dates of flowering: June 16, 1915; June 8, 1916.

16. *Bignonia capreolata* L. Cross Vine.
A plentiful vine of low grounds, named from the cross shown in a section of the stem; leaves compound, with two leaflets, and a tendril. Flowers large, yellowish red; pods large, flat. Dates of flowering: April 4, 1903; April 21, 1908; April 22, 1909; April 10, 1910; April 24, 1916.

17. *Lonicera sempervirens* L. Woodbine.
A small twining vine with opposite leaves that are glaucous-white below, the upper pair grown together so that the stem appears to grow through the leaf; flowers tubular, red without, yellow within; berries red. Common in woods and borders. Dates of flowering: April 4, 1903; April 19, 1908; April 12, 1909; March 29, 1910; April 21, 1913; May 4, 1915; April 19, 1916.

18. *Lonicera japonica* Thunb. Japanese Honeysuckle.
The common Honeysuckle vine with opposite, evergreen leaves; flowers tubular, whitish the first day and creamy the next; berries black. Introduced from eastern Asia, but has abundantly escaped and is often quite troublesome. Dates of flowering: May 5, 1903; April 22, 1910; April 29, 1913; May 10, 1915; May 9, 1916.

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A GLANCE AT THE ZOOLOGY OF TODAY[1]

By H. V. Wilson.

When zoology is mentioned, our first thoughts turn to the different kinds of animals, to the so-called species; to the birds and insects round our homes, to the fish we have caught; to the less familiar forms of the coast, the sponges, medusæ, and corals; to the beasts we have seen in zoological gardens, to the specimens exhibited in museums. This richness in variety is pleasing to most of us, and it is small wonder that the work of collecting and describing has been so actively pursued. The forms of animal life sufficiently different to be enrolled as separate species now number about half a million.

Strange as it may seem, one still at intervals hears the question, "What is the use of all these creatures?" meaning their use to us, to man. Perhaps the question is never very seriously asked today. For we all know a long list of organisms who, if they bring us tribute, bring a strange kind. We think of that prince of evil, the tiger; of the cobra; of parasitic worms that bore through the living flesh; of bacilli that bring disease after disease; of protozoa that cause malaria and sleeping-sickness. And we recognize that the material world is not obviously anthropocentric.

Modified, however, the question is a very rational one: what forms are inimical to us, what forms directly or indirectly useful? This question, essentially economic and hygienic, tends greatly to increase our interest in natural history, in the knowledge of the kinds of animals, and the changes of form, habit, and home which they un-

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dergo during individual life. We become aware how complex are the interdependencies of organisms, how interwoven are their life histories. We find that it is largely on such knowledge that the medical scientist and the sanitary engineer draw when they seek to combat the infectious diseases, and how vitally helpful such knowledge is to the various branches of animal industry.

These considerations show us plainly enough that biology is useful, and in making this statement we perhaps express the real nature of our knowledge in general, as something not final and comprehensive, but detailed and practical. Let us, however, not confound this aspect of the nature of knowledge with the method of science. Because the world is so ordered, and its ways so interconnected, that any or all knowledge may after a time prove useful, is no reason why we should concentrate our attention chiefly on tasks and problems that are of immediate practical importance. On the contrary, as we survey the history of science, we see clearly that inquiries into the causes or beginnings of things, irrespective of direct utility, are of the first importance. It is these which lead to the emergence of the great general ideas, which, in their turn, light the way to the discovery of special facts that are of direct utility.

Turning from the utilitarian aspect of biology, let us take up for a moment a problem which, never new, is yet always interesting. What is the origin of all these forms that we have learned to know? What is the nature and origin of species, or, choosing the phraseology of the day, of specific differences?

In the histories of the theory of evolution we read, wondering if any of our present-day notions shall prove as untenable, that Linnaeus held that species were changeless, that they were in character and number precisely as originally created. We read that somewhat later, when fossils were better known, Cuvier interpreted the present organisms and the very different ones of past geological periods as the results of separate acts of creation, each period with its living things coming to an end in some tremendous catastrophe. And that still later Louis Agassiz held the same view, while meantime he with many others paved the way for evolution by discoveries of fact, bringing to light the existence of fossil series from low forms to high, and

many illustrations of the generalization embodied in our "biogenetic law" of today, namely, the generalization that organisms do not pursue a straight path of development from egg to final form, but commonly develop temporary peculiarities of structure constituting resemblances to lower forms.

The strong tide of evolutionary doctrine that set in with the publication of Darwin's great book in 1859 brought nothing new to what had been taught by Louis Agassiz as regards the existence of the resemblances, just alluded to, between organisms, adult, embryonic and fossil. But that the stream of living matter has been continuous from generalized type to derived form, or, as we say, from ancestral type to descendant, this is the conception that rings out the note of difference from Agassiz's teaching. Basing its argument on minor mutability that can be demonstrated and on a mass of circumstantial evidence, overpowering in its cumulative effect, evolution claimed that fundamental resemblance is not a transcendental likeness, but is due to kinship. With this conclusion we are long familiar. It has entered into the very marrow of our mental life, and everything that we learn corroborates it. The conclusion concerns us in a direct way, for the evolutionary process cannot be thought of as something finished and done with. Rather do we conclude that if organisms *have* changed, they are still changing.

Granted the fact that organisms change, the question veers and we ask in response to what do they change? Are the changes natural phenomena throughout and, as such, due to natural causes, like the up and down heaving of the earth's crust?

We are confronted today, as in past times, with two interpretations of nature. On the one side argument, clad in the robe of philosophy, would lead us beyond the border of the phenomenal world, seeking a reality on which all phenomena are dependent. Many tell us there is such a reality—and certainly nothing that we know contradicts them. On the other hand, the obvious world is a world of natural phenomena, which, although at bottom incomprehensible, prove on study to be orderly and predictable. That is, we learn through experience that one occurrence is associated with another, that one change brings about the next, that for every effect there is a cause.

Returning to our question, it may be said that we work and work successfully on the theory that the changes which organisms undergo are natural phenomena brought about, like any others, by natural causes. The transformation of a horde of barbarians into a modern European nation; the immunity which a race acquires against specific disease; the evolution of new breeds of dogs, horses and wheat; the spreading of a race over a wide and varied area with the consequent appearance of differences which mark off the group into geographical subgroups; the gradual loss of parts of the body, so obvious in some fossil series; the metamorphosis of a part into what is virtually a new organ; the restriction of a species to a narrow area of distribution, with the final outcome, extinction; all these we are justified in regarding as natural phenomena and as phases in the wave of change that incessantly passes over living nature.

Granted the fact of change and that it is a natural phenomenon, we become interested in the analysis of its causes. And so we begin to inquire into the origin and accentuation of the small differences which mark off a race from the parent stock. Thus we pass from the wider study of evolution to the narrower and more precise study of heredity and variation. Here the experimental method is the chief one employed, although often under the guidance of comparison and statistics.

I pass over the ideas entertained as to ways in which differences are accentuated and touch, in preference, on some of the ways in which they originate. We know very well that the body of an animal, its skin, bones, muscles, etc., made up of infinite numbers of microscopic components, the cells, responds to changes in exercise, food and environment with the production of differences which are often very well marked. But we also know that the great bulk of the obvious and familiar differences so caused are not passed on to the next generation. They are not heritable. In order to be heritable, the peculiarity must be lodged, potentially, of course, in the germ cells. These are the cells, commonly ovum and sperm, which, leading a life aloof from the body cells, give rise to the new individual.

We may then ask, do all individual differences that are heritable originate from the very start in the germ cells, and, if so, owing to

what influences? or are there subtle changes of the body cells induced by habit, food and environment, which are transmitted to and lodged in some potential form, in the germ cells? This two-sided question, it is obvious, concerns mankind in a very practical way. It has been argued warmly for many years, usually under the heading of "the inheritance of acquired characters," and still today, in a more clearly circumscribed shape than formerly, makes one of the most important general problems of experimental biology.

In past years it was widely held that the transmission from body to germ was a fact, in other words, that peculiarities developing for the first time in the body, not as the result of congenital constitution, but as the result of habit or outward circumstance, were transmissible to the germ. Weismann and others have shown that much of the evidence on which this conclusion rested is weak, and the result of their criticism has been in some measure to discredit the idea. There are, nevertheless, certain experiments which, while not demonstrating transmission from body to germ, do demonstrate perhaps the more important fact that the effect on the body of outward circumstance in one generation may be in some degree repeated in the bodies of the next generation, although the conditions which first induced the change are no longer operative.

Prominent among such experiments are the classic investigations of Standfuss and Fischer on European butterflies. Both Standfuss and Fischer showed for certain species that the temperature at which the pupal stage is kept, during its so-called sleep, may be made to affect very seriously the coloration of the butterfly into which it metamorphoses. In this way by employing temperatures above the normal and temperatures below the normal, butterflies are obtained very different in appearance from the type.

Standfuss having in this way obtained strongly altered individuals, bred from them, keeping the butterflies and their offspring not at the abnormal temperature which induced the change, but at the normal temperature. The great bulk of the offspring, the second generation of butterflies, proved to adhere to the usual type of the species. Nevertheless, a few examples departed from the type and resembled in varying degrees their parents.

In a similar experiment, Fischer subjected pupæ to an intermittent cold of —8 degrees C., and in this way obtained butterflies different from the type. The offspring of these modified individuals fell into two groups, those adhering to the type and those resembling in greater or less degree the modified parents. The percentage of the latter was a considerable one.

These and numerous other experiments (such as those of Schübeler on German wheat transplanted to Norway and back again, the work of Tower on the potato beetle, that of Sumner on breeding mice at low and high temperatures, etc.) unquestionably show that the environment can exert a modifying influence on the hereditary constitution of a race, that it can originate heritable differences between organisms. They show, moreover, that it sometimes happens that a definite change is made in the body and a corresponding change in the germ cells, the change in the body of the first generation, thus showing in a measure what the heritable effect on the race will be. These important experiments mark a real advance, and it is safe to predict that they are but the precursors of many more dealing with the effect of the environment on the germ cells. At present one cannot but feel that the amount of evidence is too slim to decide the question as to whether the environment first produces an effect on the body which is then transmitted to the germ cells, or whether the environment acts directly upon the germ cells, producing in them potential changes parallel to those produced in the body.

A second way in which heritable differences between organisms originate, that is, a second way in which changes in the properties of the germ cells are induced, is through amphimixis or development from two parents, wherein two sets of hereditary tendencies are intermingled.

Adopting this general method, investigators have in recent years attacked the problems of heredity and variation from two sides. On the one hand, students of experimental embryology, cross-fertilizing the egg of one species with the sperm of another, have occupied themselves in tracing the influence of the respective parents as displayed in the growth and differentiation of the hybrid germ. Sea urchins, frogs, fish are the objects which more than others have been used

for such studies. This is too technical a field to admit of brief description. If there were time it would be easy to show that the connections between the study of embryology and heredity are numerous, close, and indeed fundamental to any real understanding of either.

The other great application of the method of cross-breeding to the study of heredity concerns itself not with the gradual individual development but with the reappearance of the characteristics of adult organisms in the offspring and later descendants. In this study a remarkable activity now reigns, dating from the year 1900, when certain principles of hereditary transmission, originally discovered by Mendel and published in 1865, but subsequently lost sight of, were rediscovered by several European botanists. These principles lie at the center of that collection of data, law and explanatory hypothesis which we designate Mendelism and which is the outcome of a vast amount of experimental breeding of animals and plants of many kinds.

The fundamental principles of Mendelism are no doubt familiar to many of you. In this study attention is concentrated not upon the influence which one parent as a whole exerts upon a descendant, but upon the transmission of particular characteristics. The characteristics to which attention is paid are those in which the two parents differ sharply. They are contrasting characters like blackness and whiteness of fur in the rabbit, tallness and dwarfness of the pea vine, roughness and smoothness of coat in the guinea pig.

The conclusion of fundamental importance is that such characters do not blend in the descendants, but are passed on from generation to generation in their original distinctness. The characters, Mendelian or unit-characters as they are called, may be obvious or latent. In the familiar case of rabbit breeding, when a black and a white rabbit are bred from, the offspring are all black, but whiteness is latent in some, for, if the black offspring are interbred, a certain proportion of white rabbits will appear among the grandchildren.

A point of importance is that the Mendelian characters of an ancestor behave in heredity independently of one another in such wise that new combinations may be made. Thus, if a dark, smooth guinea pig be bred to a white rough guinea pig, and the offspring be inter-

bred, the grandchildren will be of four kinds, with respect, that is, to the qualities darkness and whiteness, smoothness and roughness (W. E. Castle). Some will be like the grandfather and some like the grandmother. But there will be other grandchildren like neither of the grandparents. In these a grandfather feature is combined with a grandmother feature, and so we get dark rough and white smooth pigs.

Thus qualities which exist apart from one another in separate organisms may be combined in one and the same individual, and new breeds be created. In such new breeds it is apparent that new qualities are not created. What is created is a new combination. This is heritable and therefore marks off the breed from others. Hybridization here, then, originates heritable differences between organisms. It may be added that the independent behavior of Mendelian characters in heredity is not necessarily equal throughout a long series of characters. In other words, characters sometimes, perhaps always, tend to reappear in groups. This important fact has been especially brought out by recent work on the heredity of the little fruit-fly, *Drosophila* (T. H. Morgan).

In a loose and general way it has always been known that new combinations of characters occur in organisms bred from two parents. In this connection Goethe's verses have often been quoted, by Haeckel and others:

> From father I get my height
> And my earnestness;
> From mother dear my gladness of nature
> And delight in romancing.[1]

But Mendel's achievement was to discover order where no order had been recognized, to demonstrate that the combinations which are made are of a constant character and, moreover, are embodied in groups of grandchildren numerically proportionate to one another. We have seen that where, as in the case of the guinea pigs, two pairs of characters are considered, there will be four kinds of grandchildren. It may be added that in such a case the four kinds will be represented by the proportional numbers 3, 3, 9, 1. That is, for

[1] "Vom Vater hab' ich die Statur," etc.

three of one kind, there will be three of another, nine of another and one of yet another. The larger the number of contrasting points, the greater will be the number of kinds of grandchildren. Thus Correns, one of the rediscoverers of the Mendelian principles, calculates that if the first parents differ in respect to ten points there will be more than a thousand different kinds of grandchildren.

Mendel's explanation of the phenomena that now bear his name was in the shape of an hypothesis which with various alterations, some of which are important, is in general use today. He conceived of each contrasting character as potentially represented in a germ cell by a particular "something." This something we speak of as a germinal factor, a unit-factor or a gene. It is thought of as a definite entity. Many, indeed, perhaps most, look on it as a material particle. Others do not make the attempt to visualize it. When the egg and sperm fuse, corresponding germinal factors are brought together in pairs, each pair of factors representing a pair of contrasting characters, blackness and whiteness of rabbit fur, for example. Thus brought together in the fertilized egg, the two factors of a pair may each produce an effect on the body of the organism into which the egg develops. Or one factor may completely dominate the other, the organism bearing the impress of that factor alone, the other lying dormant. When, for example, in the egg of the rabbit, the factors for blackness and whiteness are brought together, the factor for blackness being dominant, the egg develops into a black rabbit. But now as the germ cells are formed which will give rise to the next generation, the factors are supposed to be sorted out among them in such wise that any one germ cell does not get both, but only one, of a pair of factors. Thus, in our example, eggs will be produced having the factor for blackness only, and others the factor for whiteness only. Similarly with the sperm cells, some will have the factor for blackness, some that for whiteness. No germ cell will have both factors. This separation of the factors with the result that the germ cells produced in an individual are unlike, is the most important feature of the Mendelian hypothesis. Working on this hypothesis, it can be calculated what will be the proportionate number of individuals embodying any particular combination of characters which, through

experiment, have been found to behave in Mendelian fashion. The hypothesis has received wide and striking confirmation in that the results of the actual breeding experiments agree closely with the calculated expectations.

Such extensive use of the unit-factor hypothesis has been made that in the graphic language of the day an organism is sometimes depicted as a bundle of separate qualities, of so-called unit-characters, each the outcome in mechanical fashion of a single discrete germinal cause, which does not vary and which is self-propagative. Viewed in this artificial light, biology assumes a rigid appearance far from its real nature, its task appearing twofold, to discover through cross breeding the elementary or unit characters of organisms and the laws governing their combination.

It should be said that such a conclusion is implied rather than positively stated in the writings I have in mind, and is expressly condemned by some prominent students of Mendelian heredity (T. H. Morgan). The facts of paleontology, anatomy and development demonstrate how artificial it is, for they show that every part and process varies among the individuals of any one time, and the *mode* or typical condition changes from age to age. Moreover, the parts of the body are so interconnected materially and their activities or functions are so interassociated, that to speak of the body as a group of units is misleading. It is to misuse the license that is only allowed in allegory, or in science for the purpose of facilitating description. A tiled floor is composed of pieces which can be taken apart and recombined. But an organism, Olivia for instance, is not a mosaic, for the items in her inventory, as "two lips indifferent red, two grey eyes with lids to them," are not separate and independent components. The essential features of an organism appear to be as closely associated, fully as inseparable, as are the corners, cleavage, color and lustre of a crystal, of calcite, for example. For given the right conditions, the germ cell or other regenerative mass will always produce them.

I hasten to remind you that "unit-character" in technical studies on Mendelian heredity has a definite meaning, referring to the class of differential features, which mark off the individuals of a race, or

of allied races, one from the other. Such would be the color of the eye, perhaps, or the fullness and curve of the lip. It is, as already said, these contrasting features in respect to which the two parents differ, which behave independently of one another and which may therefore be recombined in various ways.

The question as to the permanency of such characters in hereditary lines is interesting to all of us. There is no doubt that they are remarkably constant and persistent, but experimental breeding amply demonstrates that they are subject to the sudden changes known as mutations. It has also been demonstrated that in the course of selective breeding they undergo change (W. E. Castle). They show, then, as do the many series of intergrading organisms, that the rule of heredity over living things is not absolute. Living things, in fact, continually escape from its tyranny through modification of their germ-cell substance, modification which is brought about through interaction with the environment and through interaction with other germ-cell substances, the latter action leading not only to new combinations of the old, as in ideally strict Mendelism, but to actual change in the specific protoplasm, with the result that what are virtually new qualities emerge.

Mendelism has enormously increased the general interest in heredity, than which no subject in the whole field of science is more discussed today. In the midst of the discussions and admirable investigations dealing directly with this matter, it is well not to forget what heredity is. As Haeckel pointed out long ago, heredity is not a special organic function, but is only a name for the fact that the specific substance of the germ cell exhibits a set of properties substantially like those of the parent germ cell. In other words, heredity means that an egg behaves very much as the parent egg did, because, having essentially the same organization, it reacts to stimuli in essentially the same fashion. A sound knowledge of heredity is therefore dependent on a knowledge of the ways in which the many kinds of protoplasm respond to stimuli; in other words it is dependent on the general level of biological science.

In conclusion, let me say that the several aspects of zoölogy at which we have glanced has each an interest in itself. Otherwise

there would be no hope of advance. But they fade into one another. The data overlap and the problems merge. The geographical explorer, dealing with the distribution of animals; the classifier, discovering and arranging the diagnostic features of races and species; the descriptive anatomist skillfully tracing out details of structure in finished product and embryo; the comparative morphologist, outlining embryological sketches and life histories and applying his data to questions of evolution; the analytic embryologist, unraveling physiological factors, control of which enables him to bring into being the differences which he started out to explain; the student of hereditary transmission recording the way in which characters reappear, and his other half, the student of variation, who experimentally induces new differences—these and many others are all dealing with one and the same nature, the many-sided world of living and once living things of which we form a part. The various classes of phenomena exhibited by this world of organisms, as they are mapped out and in some degree analyzed, enter into and constitute biology. They form a vast and heterogeneous array, of which it may be said that the vastness will remain, will indeed steadily increase, but the heterogeneity should become less evident. For, as knowledge grows and hypothesis gives way to generalization, the various aspects of the living world will no doubt arrange themselves in a more and more coherent manner, that is, we shall be more and more able to assign them to empirically learned causes, to the fundamental powers of the group of protoplasms as shown in responses to stimuli.

CHAPEL HILL, N. C.

A LIST OF SYRPHIDÆ OF NORTH CAROLINA.

By C. L. Metcalf.

The following records are based primarily on the collections of the Division of Entomology of the State Department of Agriculture, extending over more than fifteen years. During this time the chief of the division, Mr. Franklin Sherman, Jr., and various assistants, have painstakingly assembled specimens and data concerning the insect fauna of the entire State. Too much credit can hardly be given to Mr. Sherman for his enthusiasm in prosecuting and encouraging, from the beginning, this important zoö-geographical work.

Two other important sources of records are the collections of Mr. C. S. Brimley, Zoölogist, chiefly from Raleigh, and those of Mr. A. H. Manee from Southern Pines. A part of the latter specimens are in the possession of Dr. R. C. Osburn, of the Connecticut College for Women, who has very kindly furnished the writer with a list of thirty species from that locality. These records are starred (*) in the following list.

During several years residence in the State, the writer gave some attention to this family, and practically all of the species have been identified or examined by him. Specimens have been examined from over fifty localities, extending from Smith Island on the extreme southeast to Jefferson on the northwest, and from Andrews on the southwest to Murfreesboro on the northeast.

On account of its range in altitude, North Carolina embraces a fauna representing four of the seven life-zones of North America, viz., the Lower Austral, the Upper Austral, the Alleghenian, and the Canadian. In order that the detailed records further on may be more significant and more readily interpreted, I indicate below the life-zone to which each of these localities is considered to belong. It must, of course, be remembered that there is no such thing as divisions between these life-zones, which grade into each other; and, consequently, the last localities listed in any zone and the first of the next may partake of the fauna of both. It is particularly impossible to list localities as belonging to the Canadian zone, since this zone in North Carolina embraces only the tops of mountains. Thus a speci-

men listed as "Grandfather Mountain" or "Highlands," unless the altitude is given, may have been taken on the highest surrounding peak or on one of the lower slopes.

LOCALITIES FROM WHICH COLLECTIONS HAVE BEEN MADE, WITH NUMBER OF SPECIES RECORDED FROM EACH, AND LIFE-ZONES INDICATED.

LOWER AUSTRAL

Smith Island.	2	species
Southport.	12	"
Wilmington.	2	"
Lake Waccamaw.	18	"
Whiteville.	2	"
Burgaw.	8	"
Willard.	1	"
Beaufort.	8	"
Lake Ellis.	1	"
Havelock.	1	"
Faison.	4	"
Washington	1	"
Pinehurst	1	"
Southern Pines	47	"
Murfreesboro	3	"
Pendleton	6	"
*Charlotte	3	"
*Holly Springs	1	"
*Raleigh	66	"
*Garysburg	1	"
Total from Lower Austral.	82	species

UPPER AUSTRAL

Norlina	1	species
Durham	2	"
Hillsboro	3	"
Greensboro	7	"
Kernersville	1	"
Ellenboro	1	"
King	1	"
Pilot Mountain	1	"
Elkin	1	"
Mount Airy	1	"
Marion	2	"
Total from Upper Austral	57	species

ALLEGHENIAN OR TRANSITION

Dendron	2	species
Black Mountain	10	"
Swannanoa	25	"
Asheville	1	"
Hendersonville	10	"
Blantyre	5	"
Lake Toxoway	4	"
Montvale	1	"
**Sunburst=Canton	28	"
**Balsam	1	"
**Highlands	6	"
Andrews	2	"
Bushnell	1	"
Whittier	1	"
Hot Springs	5	"
Cane River	1	"
Yonahlasse Road	3	"
**Blowing Rock	11	"
**Grandfather Mountain	5	"
Valle Crucis	1	"
Boone	3	"
Jefferson	5	"
Total from Alleghenian	71	species

Total from Canadian	7	species

*These localities are on the line between Lower and Upper Austral, partaking of both faunas.
**Part of the records from these localities are doubtless Canadian. However, only records which state an altitude of 5,000 feet or over are credited to the Canadian Zone.

It is of interest to compare the number of species in the different genera which have been recorded in lists from other Eastern States. Although to some extent these differences are due to the amount of attention which has been given the family by collectors, still they do indicate to some extent the richness of a given genus in these different regions. Thus there could hardly be any doubt, from the records below, that Toxomerus, Volucella, Brachypalpus, and Microdon, for example, present a richer fauna as one progresses southward; while Pipiza, Syrphus, and Tubifera, on the other hand, show a greater differentiation toward the north.

TABLE OF GENERA AND SPECIES AS RECORDED FOR CERTAIN EASTERN STATES.

Genus	Number of Species Recorded for—				
	Quebec[1]	Ohio[2]	N. J.[3]	N. C.	Fla.[4]
Paragus	1	3	3	4	1
Pipiza	3	6	4	3	2
Psilota			1	1	1
Chrysogaster	3	3	4	4	1
Chilosia	4	4	5	3	
Platychirus	2	3	4	3	
Pyrophaena	1		1		
Melanostoma	3	2	2	3	
Didea		1	1	2	
Syrphus	8	8	12	12	1
Allograpta	1	1	1	2	1
Sphaerophoria	1	2	1	1	
Toxomerus (Mesogramma)	3	3	4	5	7
Xanthogramma	1	3	4	1	1
Baccha	2	4	5	4	4
Ocyptamus		1	1	1	3
Pelecocera			1		
Sphegina	1	3	3	4	
Neoascia	1	1	2		
Brachyopa	2	1			
Rhingia	1	1	1	1	
Volucella	1	3	3	4	8
Eristalis	6	8	8	9	4
Meromacrus		1		1	2
Tubifera (Helophilus)	3	8	10	5	2
Teuchocnemis	1		2	2	
Pterallastes		1	1	1	
Mallota	2	2	2	3	1
Triodonta		1	1		
Tropidia	1	1	3	2	1

TABLE OF GENERA AND SPECIES AS RECORDED FOR CERTAIN EASTERN STATES.—CONTINUED.

Genus	Number of Species Recorded for—				
	Quebec[1]	Ohio[2]	N. J.[3]	N. C.	Fla.[4]
Myiolepta		3	1	3	
Chalcomyia		1		1	
Penthesilea (Criorrhina and Somula)	1	2	2	2	
Merapioidus		1		1	
Cynorrhina	1	3	3	4	
Brachypalpus	1	2	3	5	
Zelima (Xylota)	5	8	10	11	2
Syritta	1	1	1	1	
Ferdinandea (Chrysochlamys)		1	1	1	
Cinxia (Sericomyia)	2	2	1	2	
Milesia		1	1	1	1
Spilomyia	3	4	3	3	1
Temnostoma	2	4	4	4	
Chrysotoxum	1	1	3	2	
Sphecomyia	1	1	1	1	
Callicera			1	1	
Myxogaster			1		
Merodon	3	2	5	4	9
Ceriodes (Ceria)	1	2	1		3
Total number of genera	35	43	45	42	21
Total number of species	74	114	132	128	56

[1] Chagnon, G., Etudes Preliminaires sur les Syrphides de la Province de Quebec, Extrait du "Naturaliste Canadien," Quebec, 1901.
[2] Metcalf, C. L., The Syrphidæ of Ohio, Ohio Biol. Survey Bul., Vol. I, No. 1 (Ohio State Univ. Bul., Vol. XVII, No. 31), 1913.
[3] Johnson, C. W., Report on the insects of New Jersey, Diptera from Annual Rept. N. J. State Mus. (J. B. Smith), 1909.
[4] Johnson, C. W., Insects of Florida, Diptera Bul. Amer. Mus. Nat. Hist., Vol. XXXII, Art. III, 1913.

The following persons have contributed to our records on five or more species, and are referred to by initials in the list below:

Franklin Sherman, Jr., State Entomologist.......... 63 species.
C. S. Brimley, Zoölogist, Raleigh...... .... 59 species.
A. H. Manee, Southern Pines....................... 46 species.
Z. P. Metcalf, Entomologist, Agricultural Experiment Station .... 16 species.
R. S. Woglum, formerly Assistant State Entomologist. 13 species.
Mrs. A. T. Slosson, New York City.................. 9 species.
C. W. Johnson, Curator, Boston Society of Natural History .... 7 species.
C. L. Metcalf, formerly Assistant State Entomologist. 66 species.

Following the custom of previous lists from the State, each month has been divided into three parts; the first to the tenth being designated as early (E.), the eleventh to the twentieth as mid (M.), and the twenty-first to the end of the month as late (L.).

Detailed records are given in each case; and these, together with the table of localities by life-zones given above, should enable any one to decide as to the probable occurrence of a species in any part of the State.

In the matter of nomenclature and synonomy, the writer has followed, for the most part, the catalogue of the Diptera of the world by Dr. C. Kertesz.*

ANNOTATED LIST OF SPECIES.

PARAGUS ANGUSTIFRONS Loew.

Lake Waccamaw, E. Apr. (C. L. M.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch. (A. H. M.); *Pendleton*, E. June (C. W. J.); *Raleigh*, E. Jly. (C. L. M.), E. Aug. (F. S.).

PARAGUS BICOLOR Fabr.

Southern Pines, M. Mch. (C. L. M.); *Grandfather Mountain*, M. Sep., 5,000 ft. (Z. P. M.).

PARAGUS DIMIDIATUS Loew.

Blowing Rock, E. Sep. (C. L. M.).

PARAGUS TIBIALIS Fall.

Southern Pines, M. Mch. (C. L. M.), M. June*; *Raleigh*, E. Jly., M. Jly., E. Aug., M. Aug. (C. L. M.).

PIPIZA PISTICOIDES Willist.

Swannanoa, M. Apr., ♂ about apple blossoms (C. L. M.).

PIPIZA PULCHELLA Willist.

Southern Pines, L. Oct. (A. H. M.).

PIPIZA RADICUM Walsh and Riley.

Swannanoa, M. Apr., ♂ (C. L. M.)

PSILOTA BUCCATA Macq.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch., E. Apr., M. Apr. (A. H. M.); *Raleigh*, L. Mch., M. Apr. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.); common.

*Catalogus Dipterorum hucusque Descriptorum, Vol. VII, C. Kertesz, Museum Nationale Hungaricum, Budapest, 1910.

CHRYSOGASTER NIGRIPES Loew.

Southport, E. Apr. (C. L. M.); *Charlotte*, E. June (F. S.); *Raleigh*, M. Apr. (C. S. B. and C. L. M.); *Hendersonville*, June (F. S.).

CHRYSOGASTER NITIDA Wied.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, E. Apr.*; *Pendleton*, E. June (C. W. J.); *Raleigh*, E. Mch., M. Apr. (C. L. M.), E. June (R. S. W.), E. Jly., M. Jly., L. Jly., E. Aug. and M. Aug. (C. L. M.); *Hillsboro*, M. June (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Hot Springs*, May or June (A. T. S.); *Blowing Rock*, Sep. (F. S.). Evidently distributed throughout the state and occurring throughout the summer.

CHRYSOGASTER PICTIPENNIS Loew.

Southport, E. Apr. (C. L. M.); *Raleigh*, E. Aug., abundant, (C. L. M.).

CHRYSOGASTER PULCHELLA Willist.

Southern Pines, L. Mch.*, E. Apr. (A. H. M.).

CHILOSIA CAPILLATA Loew?

A male, *Southern Pines*, E. Apr. (A. H. M.), is doubtfully referred here. It differs from the description in the color of the pile on the frons and in lacking the groove on the scutellum.

CHILOSIA PALLIPES Loew.

Sunburst, (=*Canton*), June (F. S.).

CHILOSIA WILLISTONI Snow.

Raleigh, M. Nov. (C. L. M.)

PLATYCHIRUS CHAETOPODUS Willist.

Blantyre, E. May (F. S.).

PLATYCHIRUS HYPERBOREUS Staeger.

Raleigh, L. Mch. (C. L. M.); *Jefferson*, M. Sep. (C. L. M.).

PLATYCHIRUS QUADRATUS Say.

Raleigh, L. Mch. (F. S. and C. L. M.).

MELANOSTOMA ANGUSTATUM Willist.

Sunburst (=*Canton*), L. May (C. S. B.).

MELANOSTOMA MELLINUM Linné.

Raleigh, L. Mch. (C. S. B.), M. Apr. (C. S. B. and C. L. M.); *Hendersonville*, June, (F. S.); *Sunburst* (=*Canton*), L. May, (C. S. B.); *Jefferson*, M. Aug. (F. S.).

MELANOSTOMA OBSCURUM Say.

Southern Pines, E. Nov.*; *Raleigh*, E. Mch. (C. S. B. and C. L. M.), L. Mch., M. Apr. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.); *Sunburst* (=*Canton*), L. May (C. S. B.).

Didea fasciata Macq. *var.* fuscipes Loew.
Southern Pines, L. Mch.*; *Raleigh*, L. Mch. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.); *Sunburst* (=*Canton*), L. May (F. S.).

Didea laxa O. S.
Sunburst (=*Canton*), L. May (C. S. B., F. S. and S. C. Clapp).

Syrphus amalopis O. S.
Black Mountain, L. May (F. S.).

Syrphus americanus Wied.
Southport, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Beaufort*, M. May (R. S. W.), E. June (F. S.); *Southern Pines*, M. Mch. (C. L. M.), M. Nov. (A. H. M.); *Raleigh*, L. Jan., on wing, (C. L. M.); Feb., L. Mch. (C. S. B.), E. Mch., common, (C. L. M.), L. Mch., E. Apr. (Z. P. M. and C. L. M.), L. Apr. (C. L. M.), L. May (F. S.), L. Aug. (Z. P. M.), L. Oct. (C. L. M.), L. Nov. (C. S. B.); *Durham*, L. May (C. S. B.); *Swannanoa*, M. Apr., common, (C. L. M.); *Sunburst* (=*Canton*), L. May (C. S. B.); *Bushnell*, E. Sep. (G. M. B.); *Blowing Rock*, Sep. (F. S. and R. W. Leiby). Common throughout the state except for an apparent break between generations in summer.

Syrphus arcuatus Fall.
Raleigh, L. Mch., common about blossoming willow (C. L. M.); *Black Mountain*, L. May (F. S.).

Syrphus fisherii Walton.
Blowing Rock, Sep. (F. S.). *Male.* Oral margin and cheeks yellow, frontal triangle in the middle brownish, shining, along the eyes yellowish pollinose. Scutellum dark brown, yellow along the margin. First abdominal segment shining black, the black of the second segment opaque; yellow band about half the length of segment situated a little in front of the middle, interrupted by about one-fourth the width of the segment. Posterior margins of fourth and fifth segments narrowly yellow.

Syrphus species No. 1.
Sunburst (=*Canton*), L. May (C. S. B.).

Syrphus grossulariæ Meig. (*S. lesueurii* Macq.)
Raleigh, L. Mch. (C. S. B.), L. May (F. S.), M. Nov. (C. S. B.); *Blowing Rock*, L. Aug., Sep. (F. S.)

Syrphus perplexus Osburn
Raleigh, L. Mch., about blossoming willow (C. L. M.).

Syrphus protritus O. S.
Raleigh, L. Mch. (C. L. M.).

SYRPHUS RIBESII Linné.

Southport, E. Apr. (C. L. M.); *Southern Pines*, L. Mch.*; *Raleigh*, L. Mch. (C. S. B. and C. L. M.), Apr., M. Oct., M. Nov. (C. S. B.); *Greensboro*, L. Mch. (Z. P. M.); *Blowing Rock*, Sep. (F. S.). Reared from larva taken among *Schizoneura tessellata*, *Valle Crucis*, M. Sep. (C. L. M.).

SYRPHUS TORVUS O. S.

Southern Pines, M. Mch. (F. S. and C. L. M.); *Raleigh*, M. Mch. (C. S. B.); L. Mch. (C. L. M.), L. Apr., L. Oct., L. Dec. (C. S. B.); *Greensboro*, L. Mch., common (F. S.); *Ellenboro*, M. Mch. (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Sunburst* (=*Canton*), L. May (C. S. B.); *Grandfather Mountain*, 5000 ft., L. July (G. M. B.), M. Sep. (Z. P. M.); *Jefferson*, M. Sep. (C. L. M.).

SYRPHUS XANTHOSTOMUS Willist.

Southport, E. Apr. (C. L. M.); *Raleigh*, L. Mch. (C. L. M.), L. May (F. S.), E. June (C. S. B.); *Black Mountain*, L. May (F. S.).

SYRPHUS species No. 2.

Near *S. americanus* but has cheeks yellow and lacks the black facial stripe, *Swannanoa*, M. Apr. (C. L. M.).

ALLOGRAPTA FRACTA O. S.

Blowing Rock, Sep. (F. S.).

ALLOGRAPTA OBLIQUA Say.

Beaufort, E. May (R. S. W.), E. June (F. S.); *Southern Pines*, M. June*, M. Aug.*, L. Oct. (A. H. M.); *Murfreesboro*, E. June (C. W. J.); *Raleigh*, May (C. S. B.), M. June (R. S. W. and C. L. M.), E. July (C. L. M.), L. July (F. S.), L. Sep., Oct., M. Nov. (C. S. B.), E. Dec. (F. S.); *Norlina*, M. July (S W. Foster); *Dendron*, E. Aug. (J. P. Spoon); *Swannanoa*, M. Apr. (C. L. M.). Generally distributed throughout the state, common but seldom abundant.

SPHAEROPHORIA CYLINDRICA Say.

Beaufort, E. June (F. S.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, M. Mch. (C. L. M.), E. June*. E. Nov., M. Nov. (A. H. M.); *Raleigh*, E. Mch. (C. S. B.), L. Mch., L. Apr. (C. L. M.), June (C. S. B.), E. July (C. L. M.), L. July, M. Oct. (C. S. B.), L. Oct. (F. S.); *Charlotte*, E. June (F. S.); *King*, E. Oct. (S. C. Clapp); *Black Mountain*, L. May (F. S.); *Swannanoa*, M. Apr., M. May (C. L. M.); *Hendersonville*, June (F. S.); *Blantyre*, E. May (F. S.); *Sunburst* (=*Canton*), L. May (C. S. B.); *Yonahlosse Road*, M. Sep. (C. L. M.); *Blowing Rock*, Sep. (F. S.); *Boone*, M. Sep. (C. L. M.).

TOXOMERUS (*Mesogramma*) BOSCII Macq.

Lake Waccamaw, E. Apr. (C. L. M.); *Pendleton*, E. June (C. W. J.);

Raleigh, L. Jly. (Z. P. M.); *Sunburst* (=*Canton*), L. May (C. S. B.); *Grandfather Mountain*, M. Sep., 5000 ft. (Z. P. M.).

Toxomerus (*Mesogramma*) duplicatus Wied.
Raleigh, L. June (Z. P. M.).

Toxomerus (*Mesogramma*) geminatus Say.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Murfreesboro*, E. June (C. W. J.); *Pendleton*, E. June (C. W. J.); *Southern Pines*, E. Nov. (A. H. M.); *Raleigh*, E. Mch., M. Mch., L. Mch. (C. L. M.), M. Apr. (C. S. B.), L. June (F. S.), M. June (C. L. M.); M. Sep. (C. S. B. and C. L. M.), M. Nov. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.); *Black Mountain*, L. May (F. S.); *Yonahlosse Road*, M. Sep. (C. L. M.); *Blowing Rock*, Sep. (F. S.); *Jefferson*, M. Sep. (C. L. M.). Throughout the state, common spring and fall with an evident gap in midsummer.

Toxomerus (*Mesogramma*) marginatus Say.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Beaufort*, E. June (F. S.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch. (A. H. M.), E. Aug.,* E. Nov.,* M. Nov.,* L. Nov. (A. H. M.); *Raleigh*, L. Mch., M. Apr., E. May, E. June, M. June, E. July, M. July, L. July, E. Aug., M. Aug., L. Aug., E. Sep., M. Sep., E. Oct., E. Nov., M. Nov., L. Nov. (F. S., C. S. B., Z. P. M., C. L. M.); *Swannanoa*, M. Apr., variety, (C. L. M.), M. July, (Z. P. M.); *Hendersonville*, June (F. S.); *Balsam*, 3,500 ft., M. Sep. (Z. P. M.); *Yonahlosse Road*, M. Sep. (C. L. M.); *Blowing Rock*, E. Sep. (F. S. and R. W. Leiby); *Grandfather Mountain*, E. Sep., M. Sep., 5,000 ft. (Z. P. M.); *Jefferson*, M. Sep. (F. S. and C. L. M.). Uniformly distributed throughout the state, often very abundant.

Toxomerus (*Mesogramma*) parvulus Loew?
I refer here with some question a male, *Grandfather Mountain*, 11 Sep., '08, 5000 ft. (Z. P. M.).

This name has been considered synonymous with *T. boscii* Macq. (Hunter). The above specimen differs especially from those referred to *boscii* in lacking the conspicuous, lateral thoracic stripes, the side margins being only obscurely yellowish for a short distance above the base of the wings. Three slender, cinereous shining stripes on mesonotum. First abdominal segment more narrowly yellow at base than in *boscii* and the yellow band on second segment broader, straight, not interrupted. Yellowish fasciæ on third and fourth segments broader, the posterior processes much produced, until on the fourth segment the fascia is broken up into five longitudinal stripes by the black interruptions. Hind tibiæ mostly black, the tarsi infuscated.

Toxomerus (*Mesogramma*) politus Say.
Beaufort, M. June (F. S.); *Southern Pines*, M. Aug.*, L. Aug. (A. H. M.);

Raleigh, M. Apr. (Z. P. M.), M. June (C. S. B.), E. July (C. L. M.), M. Aug. (Z. P. M. and C. O. Houghton), Aug. (C. S. B.), L. Sep. (C. S. B. and F. S.), E. Oct. (C. L. M.), L. Oct. (C. S. B. and C. L. M.), M. Nov. (C. L. M.); *Greensboro*, L. Aug. (F. S.); *Dendron*, E. Aug. (J. P. Spoon); *Swannanoa*, M. Apr. (C. L. M.); *Asheville*, M. Aug. (G. M. B.); *Blantyre*, L. Sep. (R. S. W.); *Sunburst* (=*Canton*), June (F. S.); *Highlands*, Sep. (F. S.); *Andrews*, M. Aug. (F. S.); *Blowing Rock*, E. Sep. (F. S. and R. W. Leiby). This, the corn-feeding Syrphid-fly, is thus seen to be distributed over the state with the possible exception of the extreme southeast. The larvæ and pupæ have been found in great numbers on corn at Raleigh (Z. P. M. and C. L. M.); but their feeding did no apparent damage.

XANTHOGRAMMA EMARGINATUM Say.
Burgaw, E. Apr. (C. L. M.); *Highlands*, Sep. (R. S. W.); *Blowing Rock*, Sep. (F. S.).

BACCHA CLAVATA Fabr.
Raleigh, M. and L. Sep., 1♂, 2♀, (C. S. B.).

BACCHA COSTATA Say.
Raleigh, M. Sep. (C. S. B.).

BACCHA LUGENS Loew.
Raleigh, E. Sep. (C. S. B.).

BACCHA TARCHETIUS Walk.
Whiteville, July (R. S. W.); *Willard*, July (Z. P. M.); *Raleigh*, E. July (F. S.), M. July (C. S. B.); *Albemarle*, E. Aug. (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Hendersonville*, June (F. S.); *Sunburst*, L. May (C. S. B.); *Hot Springs*, May or June (A. T. S.).

OCYPTAMUS (*Baccha*) FUSCIPENNIS Say. [nec *Baccha fascipennis* Wied. (*B. aurinota* Walk)].
Beaufort, M. June (F. S.); *Whiteville*, July (R. S. W.); *Washington*, M. July (F. S.); *Southern Pines*, M. Nov.*; *Raleigh*, L. May (C. S. B.), E. July (F. S.), M. July (C. S. B.), L. July (C. L. M.), E. Aug. (C. L. M.), M. Aug. (C. O. Houghton), E. Sep. (F. S. and C. S. B.), L. Sep., L. Oct. (C. S. B.); *Black Mountain*, L. May (F. S.); *Sunburst*, (=*Canton*), L. May (C. S. B.); *Hot Springs*, May or June (A. T. S.); *Blowing Rock*, M. Sep. (F. S. and C. L. M.).

SPHEGINA INFUSCATA Loew.
Sunburst (=*Canton*), L. May (C. S. B.).

SPHEGINA KEENIANA Willist.
Sunburst (=*Canton*), L. May (F. S. and C. S. B.).

Sphegina lobata Loew.
Sunburst (=*Canton*), L. May (C. S. B.).

Sphegina rufiventris Loew?
A number of light-colored specimens, *Swannanoa*, M. Apr. (C. L. M.), may be teneral individuals of this species.

Rhingia nasica Say.
Raleigh, L. Apr. (C. L. M.), E. Nov. (C. S. B.); *Black Mountain*, L. May (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Lake Toxoway*, May or June (A. T. S.); *Homestead*, M. Aug. (S. W. Foster); *Sunburst*, (=*Canton*), L. May (C. S. B. and F. S.), June (F. S.); *Highlands*, Sep. (F. S.); *Blowing Rock*, Sep. (F. S.); *Grandfather Mountain*, 4,000 to 5,000 ft. E. Sep. (F. S.); *Jefferson*, M. Sep. (F. S.).

Volucella fasciata Macq.
Southern Pines, L. June*, E. Sep.*. A male, *Southern Pines*, M. Mch. (C. L. M.), has the antennæ entirely brownish; the yellow markings on thorax much less distinct; and the abdomen with only two yellow bands, the one on the third segment much attenuated toward the middle, almost disappearing, and both fasciæ widely separated from the margin.

Volucella pallens Wied. (*V. sexpunctata* Loew).
Raleigh, L. July (C. S. B.), M. Aug. (C. L. M.).

Volucella vesiculosa Fabr.
Raleigh, M. May (C. S. B.), L. May (F. S.). In sugar trap, M. June, L. June, M. July, L. July (C. S. B.); *Blantyre*, E. May (F. S.).

Eristalis aenea Scop.
Charlotte, E. June (F. S.); *Raleigh*, L. Mch. (F. S. and C. S. B.), E. May (C. S. B.), June, July (C. S. B.), M. Aug. (C. L. M.), E. Oct. (F. S.), M. Oct., Nov. (C. S. B.); *Hillsboro*, M. June (F. S.); *Greensboro*, L. Mch. (Z. P. M.); not common.

Eristalis albifrons Wied.
Beaufort, E. July (F. S.).

Eristalis arbustorum Linné.
Raleigh, L. Mch., M. Apr. (C. L. M.), May (C. S. B.), E. Jly. (C. S. B. and C. L. M.), E. Aug. (F. S. and C. S. B.), M. Aug. (C. L. M.); *Durham*, L. May (C. S. B.); *Blowing Rock*, Sep. (F. S.).

Eristalis dimidiata Wied.
Smith Island, Oct. (F. S.); *Southport*, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Faison*, M. Oct. (F. S.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch., L. Apr., E. Sep.,

L. Sep.*, E. Nov.*, M. Nov.* (A. H. M.); *Raleigh*, E. Mch. (C. L. M.), Mch. (C. S. B.), L. Mch., E. Apr. (F. S.), Apr., E. May (C. S. B.), L. Sep. (F. S.), E. Oct. (C. S. B.), E. Nov. (F. S.), M. Nov. (C. S. B.); *Greensboro*, L. Mch. (F. S.).

ERISTALIS FLAVIPES Walk.
Raleigh, L. Oct. (F. S.).

ERISTALIS SAXORUM Wied.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr., abundant (C. L. M.); *Lake Ellis* (*Havelock*), E. May (C. S. B.); *Raleigh*, M. June (C. S. B.).

ERISTALIS TENAX Linné.
Lake Waccamaw, E. Apr. (C. L. M.); *Beaufort*, E. June (F. S.); *Southern Pines*, M. Mch. (C. L. M.), E. June (R. S. W.), E. Nov.*, M. Nov.* (A. H. M.); *Holly Springs*, in collection R. F. Collins, (F. S.); *Raleigh*, L. Jan., on wing (C. L. M.), E. Mch. to L. July and E. Oct. to L. Dec. (F. S., C. S. B., C. L. M.); *Hillsboro*, M. June (F. S.); *Greensboro*, M. Mch. (S. C. Clapp), L. Mch. (F. S.); *Kernersville*, M. June. (F. S.); *Pilot Mountain*, M. Nov. (G. M. Bently); *Marion*, M. July (F. S.); *Black Mountain*, L. May (F. S.); *Hendersonville*, June (F. S.); *Sunburst* (=*Canton*), L. May (F. S. and S. C. Clapp); *Blowing Rock*, L. June (F. S.), E. Sep., common, M. Sep. (F. S.). Everywhere abundant spring and fall. There are no records of its occurrence for August or September, which probably indicates two distinct generations a year.

ERISTALIS TRANSVERSA Wied.
Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Faison*, M. Oct. (F. S.); Murfreesboro, E. June (C. W. J.); *Pendleton*, E. June (C. W. J.); *Southern Pines*, L. Mch.*, E. Apr. (C. L. M.), E. Nov.*, (A. H. M.); *Elkin*, M. June (F. S.); *Raleigh*, L. Mch. (C. S. B.), E. Apr. (F. S.), M. Apr., L. Apr., E. May (C. L. M.), M. May (Z. P. M.), M. June (R. S. W.), E. Jly. (C. L. M.), L. Jly. (C. S. B.), E. Aug., L. Aug. (C. L. M.), M. Sep. to L. Dec. (C. S. B.); *Hendersonville*, June (F. S.); *Swannanoa*, M. Apr. (C. L. M.); *Highlands*, Sep. (R. S. W.); *Whittier*, M. Sep. (F. S.); *Cane River*, Sep. (F. S.); *Blowing Rock*, E. Sep., common (F. S.); *Boone*, M. Sep. (C. L. M.). Common throughout the state spring and fall, rare or wanting August and September.

ERISTALIS VINETORUM Fabr.
Wilmington, M. Nov. (F. S.) ; *Faison*, M. Oct. (F. S.); *Southern Pines*, Jly. (A. H. M.), L. Aug.*, E. Sep.*; *Raleigh*, L. Mch., M. June, L. Jly., L. Sep., Oct. (C. S. B.).

MEROMACRUS ACUTUS Fabr. (*Pteroptila crucigera* Wied.).
Raleigh, L. July (Z. P. M. and C. S. B.), E. Aug., L. Sep. (C. S. B.); *Blantyre*, M. June (R. W. Collett).

TUBIFERA (*Helophilus*) CHRYSOSTOMA Wied.

Raleigh, E. May, M. June, M. July (C. L. M.), L. July (C. S. B. and C. L. M.), E. Aug., M. Aug. (C. L. M.), L. Sep. (F. S.).

TUBIFERA (*Helophilus*) FLAVIFACIES Bigot?

Raleigh, M. July (C. S. B.). This specimen differs from the specimen referred to T. INTEGRA (q. v.) in having the first yellow, abdominal band not interrupted in the middle and the fifth segment unmarked with black. The hind tarsi are infuscated but not blackish. The hind femora with less black, the abdomen as a whole more yellowish.

TUBIFERA (*Helophilus*) INTEGRA Loew.

Raleigh, E. Aug., on mint (C. S. B.).

TUBIFERA (*Helophilus*) LAETA Loew.

Southern Pines, L. June*.

TUBIFERA (*Helophilus*) SIMILIS Macq.

Smith Island, M. Oct. (F. S.); *Southport*, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Faison*, M. Oct. (F. S.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch.*, E. Apr., M. Apr. (A. H. M.); *Raleigh*, L. Mch. (C. S. B.), M. Apr. (C. S. B. and C. L. M.), E. Oct., L. Oct., M. Nov. (C. S. B.).

TEUCHOCNEMIS BACUNTIUS Walk.

Southport, E. Apr., 2♀, 1♂, (C. L. M.); *Lake Waccamaw*, E. Apr., ♀, (C. L. M.); *Southern Pines*, E. Apr. (A. H. M.).

TEUCHOCNEMIS LITURATA Loew.

Raleigh, M. Apr. (C. S. B.).

PTERALLASTES THORACICUS Loew.

Hendersonville, June (F. S.); *Blowing Rock*, E. Sep., 3500 ft. (F. S.).

MALLOTA CIMBICIFORMIS Fall.

Southern Pines, L. Mch.* (A. H. M.).

MALLOTA POSTICATA Fabr.

Raleigh, L. Apr. (F. S.), L. May, M. June (C. S. B.), L. Aug. (F. S.), L. Oct. (F. S.); *Black Mountain*, L. May (F. S.); *Sunburst* (=*Canton*), June (F. S.).

MALLOTA SP.

Southport, E. Apr. (C. L. M.). ♀, nearest M. CIMBICIFORMIS but quite distinct.

TROPIDIA ALBISTYLUM Macq.

Raleigh, M. Apr., ♂, (C. L. M.); *Sunburst* (=*Canton*), June, ♀, (F. S.); *Hot Springs*, May or June (A. T. S.).

TROPIDIA QUADRATA Say.

Raleigh, May to Sep. (C. S. B.), M. Aug. (C. L. M.).

MYIOLEPTA NIGRA Loew.

N. C. (Williston, **p. 129).

MYIOLEPTA STRIGILATA Loew.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Southern Pines*, E. Apr. (A. H. M.); *Raleigh*, L. Mch., L. Apr., M. Apr., (C. L. M.). No evident luteous spot on side of face.

MYIOLEPTA VARIPES Loew.

Raleigh, May (C. S. B.).

CHALCOMYIA AEREA Loew.

Southern Pines, L. Mch.* (A. H. M.).

PENTHESILEA (*Somula*) DECORA Macq.

Raleigh, L. Apr., M. May (C. S. B.); *Mount Airy*, June (Z. P. M.); *Swannanoa*, M. Apr. (C. L. M.); *Lake Toxoway*, May or June (A. T. S.).

PENTHESILEA (*Criorrhina*) VERBOSA Walk.

Montvale, L. Apr. (F. S.).

MERAPIOIDUS VILLOSUS Bigot.

Greensboro, L. Mch. (F. S.).

CYNORRHINA NOTATA Wied.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, L. Mch.*, E. Apr. (A. H. M.); *Lake Toxoway*, May or June (A. T. S.).

In some female specimens, the four anterior femora are entirely yellowish. Front black above, cheeks broadly entirely black, face yellowish.

CYNORRHINA PICTIPES Bigot.

Southport, E. Apr., abundant, (C. L. M.); *Burgaw*, E. Apr., abundant, (C. L. M.); *Southern Pines*, E. Apr.* (A. H. M.); *Raleigh*, M. Apr. (F. S. and C. S. B.); *Swannanoa*, M. Apr. (C. L. M.).

CYNORRHINA UMBRATILIS Willist.

Southern Pines, E. Apr. (A. H. M.); *Raleigh*, L. Apr. (C. L. M.); *Swannanoa*, M. Apr., about Juneberry (C. L. M.).

CYNORRHINA SP.

♂ *Southern Pines*, E. Apr. (A. H. M.). Near C. NOTATA but differs in abdominal markings, in having a black facial stripe and black on frontal triangle above.

**Williston, Samuel W., Synopsis North American Syrphidæ, Bul. U. S. Natl. Museum, No. 31, Wash., 1886.

Brachypalpus amithaon Walk.
N. C., (Williston, *loc. cit.*, p. 297).

Brachypalpus frontosus Loew.
Southern Pines, M. Mch.*; *Raleigh*, Mch. (C. S. B.), L. Mch. (C. L. M.).

Brachypalpus pulcher Willist.
Southern Pines, 24 Feb. (A. H. M.).

Brachypalpus rileyi Willist.
N. C. (Williston, *loc. cit.*, p. 222).

Brachypalpus sorosis Willist.
Southern Pines, E. Mch., L. Mch.*, E. Apr., M. Apr. (A. H. M.).

♀. Front black, on the vertex shining, metallic bronze; below opaque; covered with whitish pubescence, which on the sides next the eyes entirely obscures the black ground color; pile yellow. Entire antennal prominence and face yellow, shining in the middle, whitish pubescent on the sides. Cheeks shining black. Thorax similar to the male, the notum a little less brilliantly bronze. Abdomen as in the male. Legs and antennæ entirely yellowish, only the tips of the tarsi infuscated; although in some of the males the femora are black, except at base and apex, and the antennæ decidedly infuscated.

Zelima (*Xylota*) analis Willist.
Lake Waccamaw, E. Apr. (C. L. M.).

Zelima (*Xylota*) angustiventris Loew.
Southern Pines, M. June*; *Lake Toxoway*, May or June (A. T. S.); *Blowing Rock*, 3500 ft., E. Sep. (F. S.).

Zelima (*Xylota*) anthreas Walk.
Lake Waccamaw, E. Apr. (C. L. M.).

Zelima (*Xylota*) bicolor Loew.
Hendersonville, June (F. S.).

Zelima (*Xylota*) chalybea Wied.
Raleigh, E. June (F. S.), M. June (C. S. B.).

Zelima (*Xylota*) ejuncida Say.
Southern Pines, E. Apr. (A. H. M.); *Raleigh*, E. Sep. (C. L. M.); *Sunburst* (=*Canton*), L. May (C. S. B.).

Zelima (*Xylota*) elongata Willist.
Sunburst (=*Canton*), June (F. S.); *Blowing Rock*, 4,000 to 4,500 ft., June 20, 1904 (F. S.).

ZELIMA (*Xylota*) FRAUDULOSA Loew.

Lake Waccamaw, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Pendleton*, E. June (C. W. J.); *Raleigh*, L. Apr. (C. L. M.); *Swannanoa*, M. Apr. (C. L. M.). A ♀, *Raleigh*, E. June (C. S. B.), has front and middle legs and basal half of hind femora yellow. It may be distinct.

ZELIMA (*Xylota*) MARGINALIS Willist.

Sunburst (=*Canton*), L. May (F. S.).

ZELIMA (*Xylota*) PIGRA Fabr.

Lake Waccamaw, E. Apr. (C. L. M.); *Burgaw*, E. Apr. (C. L. M.); *Southern Pines*, M. Mch. (C. L. M.), L. Mch.*, E. Apr., M. Aug.* (A. H. M.); *Pinehurst*, M. Oct. (F. S.); *Raleigh*, Apr., L. June, L. July, Sep., Oct. (C. S. B.); *Garysburg*, E. Apr. (F. S.).

This species was reared in large numbers from larvæ collected by Professor Z. P. Metcalf at Raleigh. I quote from his letter as follows: "The Syrphidæ were collected under the bark of two pine logs about 2 feet in diameter. These logs had evidently been cut during the preceding summer and the inner bark was badly decayed and had an abundant growth of a slimy fungus of some kind. Both logs were on a hillside and the lower ends of the logs had the most larvæ—perhaps due to the fact that water had run down them so that the lower end was the dampest part. The specimens were collected March 13; and at that time about two-thirds were in the puparium. After being brought back to the laboratory more of them pupated, but these were not separated from the general lot. The larvæ seemed to feed on the decaying inner bark, so far as I could judge." The adults emerged, in the laboratory, during the latter part of March and early April. The species has previously been reared by Messrs. C. W. Johnson and V. A. E. Daecke.

ZELIMA (*Xylota*) VECORS O. S.

Black Mountain, L. May (F. S.)

ZELIMA (*Xylota*) SP.

Southport, E. Apr. (C. L. M.); *Lake Waccamaw*, E. Apr. (C. L. M.); *Southern Pines*, L. Mch. (A. H. M.).

SYRITTA PIPIENS Linné.

Southern Pines, L. Mch., L. Aug.*, E. Sep.*, E. Nov., M. Nov.* (A. H. M.); *Raleigh*, M. Apr., L. Apr. (C. L. M.), E. May (C. S. B.), L. June (Z. P. M.), E. July, M. July (C. L. M.), L. July (C. S. B.), M. Aug. (C. L. M.), L. Sep., E. Oct. (C. S. B.), M. Nov. (F. S.); *Blowing Rock*, M. Sep. (F. S. and C. L. M.); *Boone*, M. Sep. (C. L. M.); *Jefferson*, M. Aug. (F. S.), M. Sep. (C. L. M.).

FERDINANDEA (*Chrysochlamys*) DIVES O. S.

Southern Pines, L. Mch. (A. H. M.); *Raleigh*, L. Oct., ♀ in moth trap (C. S. B.); *Swannanoa*, M. Apr., 2 ♀ about Juneberry (C. L. M.).

CINXIA (*Sericomyia*) CHRYSOTOXOIDES Macq.
Highlands, Sep. (R. S. W.); *Grandfather Mountain*, E. Sep., 4000 ft. (F. S.).

CINXIA (*Sericomyia*) SP.
Raleigh, L. Mch. (F. S.), M. Apr. (C. L. M.).

MILESIA VIRGINIENSIS Drury (*M. ornata* Fabr.).
Havelock, L. May (F. S.); *Southern Pines*, M. May, L. May, E. June, M. June (A. H. M.); *Raleigh*, E. June (F. S.), June (C. S. B.), E. July (C. L. M.), July, Aug. (C. S. B.), M. Aug. (C. L. M.), Oct., E. Nov. (C. S. B.); *Marion*, M. July (F. S.); *Hot Springs*, May or June (A. T. S.); *Blowing Rock*, L. June (F. S.). Not uncommon.

SPILOMYIA FUSCA Loew.
Highlands, Sep. (R. S. W.); *Blowing Rock*, E. Sep., 3,500 ft. (F. S.).

SPILOMYIA HAMIFERA Loew.
Southern Pines (A. H. M.); *Hendersonville*, June (F. S.).

SPILOMYIA LONGICORNIS Loew.
Southern Pines, E. Oct. (A. H. M.); *Raleigh*, M. Sep. (C. S. B.), L. Sep. (F. S.), Oct. (C. S. B.).

TEMNOSTOMA ALTERNANS Loew.
Sunburst (=*Canton*), L. May (C. S. B.).

TEMNOSTOMA BOMBYLANS Fabr.
Sunburst (=*Canton*), L. May (C. S. B.); *Andrews*, M. May (F. S.).

TEMNOSTOMA PICTULUM Willist.
Raleigh, M. Apr. (C. S. B.).

TEMNOSTOMA TRIFASCIATUM Roberts.
Sunburst (=*Canton*), June (F. S.).

CHRYSOTOXUM LATERALE Loew.
Raleigh, L. Mch., ♀ on sassafras flowers (C. S. B.); *Swannanoa*, M. Apr. (C. L. M.).

CHRYSOTOXUM PUBESCENS Loew.
Southern Pines, E. June *; *Raleigh*, L. Mch. (C. S. B.).

SPHECOMYIA VITTATA Wied.
Raleigh, L. Mch. (C. L. M.).

CALLICERA JOHNSONI Hunter.
Swannanoa, M. Apr., ♀ about apple blossoms (C. L. M.). This speci-

men compared with the type in the Boston Society of Natural History agrees with it almost exactly, particularly in the color of the pile which is gray throughout.

CALLICERA JOHNSONI Hunter *var.* AURIPILA n. var.

In contrast with the above typical specimen, are about forty specimens of this rare genus, taken by the writer at *Southport*, 6 and 7 April, 1914, (cotypes) about blossoming apple and pear. These specimens, together with one from *Southern Pines*, 17 April (A. H. M.), are all very similar, except for a considerable variation in size, and all strikingly different from the typical *johnsoni* in having the pile throughout of a beautiful, deep golden color. These specimens constitute a distinct new variety.

MICRODON FUSCIPENNIS Macq.

Wilmington, Sep. (R. S. W.); *Swannanoa*, E. July (C. L. M.); *Sunburst* (=*Canton*), June (F. S.).

MICRODON LIMBUS Willist.

Southern Pines, (A. H. M.).

MICRODON PACHYSTYLUM Willist.

Southern Pines, Sep. (R. S. W.), L. Sep.*; *Raleigh*, M. June (C. S. B.), E. July (Z. P. M.), L. July (C. S. B.), L. Aug. (F. S.).

MICRODON TRISTIS Loew.

Sunburst (=*Canton*), June (F. S.). Larvæ collected at Raleigh in February, 1916, by Mr. C. S. Brimley from a decaying log at the edge of a pond were reared by the writer, the adults emerging about the middle of March. Mr. Brimley concluded from the very wet habitat that the larvæ could hardly have been associated with ants. However, the presence of a single ant among the material forwarded probably indicates that the ants had been present and were mostly driven away by the water, leaving these synokoetes behind.

OHIO STATE UNIVERSITY,
Columbus, Ohio.

ON THE OCCURRENCE AND DISTRIBUTION OF POTASSIUM IN NORMAL AND NEPHROPATHIC KIDNEY CELLS.[1]

By Wm. deB. MacNider.

The observations which are contained in this summary are based on the microchemical demonstration of potassium in the kidney cells of thirty-four dogs. The animals have varied in age from four months to something over ten years. Four of the animals may be grouped as "normal animals." They did not receive any nephrotoxic substance and neither were they subjected to the action of an anesthetic. After a period of three days of observation these animals were killed by shooting.

The remaining thirty animals were rendered nephropathic by uranium nitrate in the dose of 4 mg. or 6.7 mg. per kilogram. They were anesthetized by either Gréhant's anesthetic in 60 per cent strength, or by morphine-ether.

At the termination of the experiment small pieces of kidney tissue were removed, and frozen sections not over 20 micra in thickness were made. The sections were treated at once with Erdmann's[2] reagent as modified by Macallum[3] and used by him in his studies "On the Distribution of Potassium in Animal and Vegetable Cells."

The reagent which consists in a solution of the hexanitrite of cobalt and sodium serves as a complete precipitant of potassium from its solutions, in the form of an orange-yellow precipitate of the triple salt. If the salt is present in minute quantities the crystalline form is absent. To render the detection of small quantities of the salt possible, Macallum[3] used ammonium sulphide to react with the cobalt of the salt and form the black sulphide of cobalt, which is easily detected. This suggestion of Macallum's has been employed in the demonstration of potassium in all of the sections.

The results which have been obtained are as follows:

1. The epithelial cells of the normal dog kidney show only traces

[1]Reprinted from the Proceedings of the Society for Experimental Biology and Medicine, 1915, xiii, p. 10-12. Aided by a grant from the fund for scientific research of the American Medical Association.

[2] "Anorganische Chemie," 1898, p. 630. Reference given by Macallum.

[3] *Jour. Phys.*, Vol. XXXII, No. 2, p. 98.

of potassium. The potassium is most marked in the loops of Henle and is fairly evenly distributed throughout the cytoplasm of the cells. It has never been demonstrated within the nucleus of the normal cell.

2. The epithelium of the nephropathic kidney shows an increase in potassium over that of the normal. The potassium differs in distribution within the cytoplasm of the cell and has been demonstrated within the nucleus of the cell.

3. The potassium in the nephropathic organs has been especially marked in the cells of the convoluted tubules. In the cytoplasm of the cells forming these tubules the potassium is not uniformly distributed but is found to collect along the free margin of the cells bordering the lumen of the tubule. A similar observation on the distribution of potassium salts was first made by Macallum[1] in his studies of the frog kidney in which a decinormal solutions of potassium chloride was injected into the dorsal lymph sacs of frogs.

4. Such accumulations of potassium salts are as marked in the kidney epithelium of nephropathic animals which are polyuric as they are in the nephropathic animals which have been rendered anuric.

5. The above observation would tend to minimize the importance of potassium in being responsible for a lack of function on the part of the kidney.

6. The age of the animal has apparently no constant influence on the amount of potassium microchemically demonstrable. However, the oldest animal of this series showed the most marked potassium precipitate. In this animal, and one other of the series, which were anuric from uranium, and in which the epithelium of the convoluted tubules had undergone a severe swelling and partial necrosis, not only did the cytoplasm of these cells give the potassium reaction but potassium was also demonstrated in the nucleus of the cell.

CHAPEL HILL, N. C.

[1] *Science*, Vol. XXXII, No. 824, p. 497.

PROFESSOR CAIN'S CONTRIBUTIONS TO THE SCIENTIFIC STUDY OF EARTH PRESSURE: A PIONEER WORK*

ARCHIBALD HENDERSON.

The important work by Professor Cain, which has recently appeared, breaks new ground and lays the foundation for important advances by future scientists. The theories of earth pressure here set forth with particularity, and developed in detail, apply not only to earth supposed to be endowed with friction alone, but also for earth endowed with both friction and cohesion. The importance of this may be recognized in view of the fact that from the time of Coulomb down to the present, cohesion in earth has been neglected—notably by famous investigators like Poncelet and Weyrauch, who accepted Coulomb's hypothesis, and by the noted English engineering authority, Rankine.

I.

The first treatise dealing specifically with coherent earth was that of Résal, toward the close of the year 1910.[1] Before this, the subject had been ignored, except for the solution of the simplest case by Scheffler, that of the pressure on a vertical plane in an indefinite mass of earth with a horizontal surface. It is significant that even this attempt at a solution was shown to be incorrect by Professor Cain in his elaborate paper entitled "Experiments on Retaining Walls and Pressure on Tunnels."[2] Professor Cain set forth the correct interpretation of Scheffler's result in this paper, which was first published in January, 1911,[3] although not finally published, with accompanying discussions by other engineers, in the "Transactions" until the following June. This is a chronological detail of scientific importance, for Professor Cain's conclusions appeared simultaneously with Résal's treatise, and for the simple case treated by Cain, Résal's conclusions agreed with those of Cain. Attention should also be called

Earth Pressure, Retaining Walls and Bins. By William Cain. John Wiley & Sons, Inc., New York. 1916.

[1] *Poussee des Terres, II.* "Terres Cohérentes."

[2] Transactions Am. Soc. C. E., Vol. LXXII (1911).

[3] "Proceedings," Am. Soc. C. E.

to the fact that in this paper Cain, for the first time, gave a complete *graphical* method for finding pressures on any plane in a mass of earth endowed with both friction and cohesion ("coherent earth"), which method is set forth in the present work.

Hitherto no investigation has developed any sort of general graphical method. Consequently the volume under discussion is unique in this respect. This is a striking and valuable feature of the book, as it displays the superiority of Cain's researches in this respect to those of Résal. This is demonstrated by the fact that while the graphical method is applicable in all generality, the problem cannot be solved by Résal's analytical method when the earth's surface is not one plane. Moreover, the pressure against retaining walls, when wall-friction is included, is likewise not amenable to treatment by the analytical method of Résal. Cain's graphical method also lends itself easily to the estimation of the pressure against the bracing in trenches.

The final formulas deduced by Résal were traversed subsequently by Cain, who employed a method somewhat analogous, yet involving a different independent variable. The four different cases (two for active thrust and two for passive thrust) were thereby treated separately, conducive to much simplification. On the other hand, Résal combines all four cases in one solution; but this treatment, while commendable on the score of generality and precision, renders the analysis difficult and obscure. On the whole, Résal's entire treatment is full of difficulties even for the trained mathematician and engineer.

II.

Owing to the fact that this purely analytical treatment which he had employed resulted in equations too cumbrous for practical use, except in the simple case of earth level at top, Cain did not publish his analytical results, but approached the problem anew through the intermediary of Mohr's "Circular Diagram of Stress," which Professor Basquin had utilized in his notable paper on "Internal Friction," etc.[4] After demonstrating the principles relating to the "circular diagram of stress" by an independent investigation, Cain then applied this diagram method to the subject of coherent earth. It not

[4]Western Soc. C. E., Sept. 9, 1912.

only offered the very simplest solution, but afforded a practical solution for the general case of the surface sloping at any angle—a fact already pointed out by Basquin in his paper, already referred to. This method gave the unit pressures at any depth and the *surfaces of rupture,* which are curved, except in the case of the horizontal surface, when they are planes. By means of this treatment, formulas were easily deduced for active or passive thrust for earth surface horizontal and for depth at which the thrust is zero, greatest depth for equilibrium, etc.

The results for coherent earth appear in Chapter V of the volume under review—which also contains an original treatment of "Pressures on Tunnel Linings" for dry or saturated earth, based in part on Janssen's "bin theory"; and the subject of "heaving" in foundations, leading to the formulas given by Bell, who employed a different method, yet one awkward in the handling.

The treatment of coherent earth in Chapter V is assuredly one of the distinguishing features of the work. It is the first and only treatment of coherent earth in English and is totally different from Résal's method, although leading to the same results. The checks upon the accuracy of the results are amply afforded, both by Résal's analysis and by Cain's analytical method which as yet remains unpublished.

III.

To make a survey of the contents of the book, the laws of friction and cohesion of earth are fully stated in Chapter I, which also contains tables of the few coefficients thus far found experimentally.

In the "Proceedings Am. Soc. C. E." for December, 1915, Professor Cain strongly pressed the urgent need for "extensive experimentation." In answer to this strong plea, the sub-committee on earth pressures have offered to carry on the experimentation so urgently needed at the Pittsburg laboratory of the U. S. Bureau of Standards. The theory of coherent earth cannot, of course, be applied in practice until, for the earth in question, the simultaneous coefficients of friction and cohesion are found. No wholly satisfactory mechanical apparatus for effecting this has yet been devised—

the defects being pointed out by Professor Cain in his "closure" on his paper to be published in "Proceedings Am. Soc. C. E." for August, 1916.

IV.

The remaining chapters of the book deal with earth, supposed to be devoid of cohesion, as in the case of dry sand, gravel or rip-rap—the "granular material" of the usual theories. The Rankine theory is almost universally used in England and America, although it strictly applies only to a limitless granular mass with a plane upper surface. In such a mass, subjected to no force but its own weight, the pressure on a vertical plane acts parallel to the surface.

This theory is very fully treated by two independent methods. In Chapter III, Art. 48, the Rankine formula is found by aid of the sliding wedge hypothesis, in Art. 59 by use of the "ellipse of stress." In Art. 65, Professor Cain derives in an original and simple way formulas for determining the planes of rupture.

In Chapter I the direction of the pressure against a rough retaining wall is fully investigated—a subject neglected in other books written in English. In this way it is clearly demonstrated that the Rankine method is strictly inapplicable to finding the earth pressure against a retaining wall except in certain cases.[5] From the time of Poncelet, the French have allowed for wall-friction, as has the present author. The most noted French authors—Boussinesq and Résal—follow this lead, though they assume (for the sake of simplicity in the calculations merely) that the friction of earth on wall is the same as that of earth on earth. This cannot be true when the wall has a plane interior surface and is lubricated with water from rains. Cain includes this case and makes out all the tables for thicknesses of the various types of retaining walls, as given on pages 110 to 124, on this basis.

In Chapter II complete graphical methods for finding earth pressure are given, these being based in part upon Eddy's constructions in his "Graphical Statics"; also testing and design of walls. The important case of "the limiting plane" is fully discussed. It is the

[5] Cf. p. 51, figures 14 and 15.

only treatment of this important practical subject ever given. It agrees with the limited results of Résal and Boussinesq, derived by an independent, indirect process.

In Chapter III the sliding-wedge hypothesis is again used to deduce formulas for earth thrust, as well as shorter graphical methods. The author here follows the line of his own treatment, first given by him in his "Practical Designing of Retaining Walls." The treatment in the work under review is superior in arrangement and more comprehensive in scope.

In Chapter IV the designing of walls of types 1 to 5, etc., has already been alluded to. Here the design of usual types of reinforced concrete walls is taken up in great detail (pages 124-167). The estimation of earth is only one phase of the subject. Properly to discuss the toes, heels or counterforts, the "Theory of Wedge-shaped Reinforced Concrete Beams" had to be entered into, as given in Appendix I. The two theories submitted are approximations, since no practical exact theory is possible; and the treatment is complete for stresses due to bending, shear or band stresses. In justice to the author it should be explicitly stated that this appendix and its applications in Chapter IV constitute a distinctive and entirely original feature of the work.

In Chapter VI the usual Janssen bin theory, for "deep bins," is given and applied. No exact theory for "shallow bins" can be devised, it would appear, and each of the four (approximate) theories given is open to criticism. Still, in the case of the symmetrical hopper bin, coal heaped, the results are almost free from criticism; and, fortunately, this is the design nearly always met with in practice. Similarly, the graphical solution given for the "unsymmetrical bin" (page 232) is moderately satisfactory; indeed, it is the first rational solution ever given of this case.[6]

In Appendix II the author has set forth a few of the results of experiments on model retaining walls, with discussion, extracted from his own elaborate paper, entitled, "Experiments on Retaining Walls," etc." *Trans. Am. Soc. C. E.*, Vol. LXXII, 1911.

[6]Professor Cain has pointed out that Ketchum's treatment is ludicrous, being in actual violation of the laws of statics.

In view of the particularity with which the contents of the book have been described above, it is unnecessary, in summary, to say more than this: that Professor Cain in this work has rendered a conspicuous service to the engineering profession in the United States, and given powerful impetus to a subject of permanent and rapidly growing importance. For this, the country and the American engineer owe him a genuine debt of gratitude.

A CORRECTION.

In a "List of Plants Growing Spontaneously in Henderson County, N. C.," published in this Journal January, 1915, *Prunus umbellata* Ell. was included. This is an error and it should, therefore, be stricken from the list.

ED. R. MEMMINGER.

FLAT ROCK, N. C., June 12, 1916.

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PROCEEDINGS OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY, DECEMBER, 1912, TO DECEMBER, 1916

203d Meeting—February 11, 1913

A. H. Patterson: Photography of Sound Waves. Illustrated.

W. DeB. MacNider: Difference in the Effect of Grehant's Anesthetic and Morphine-Ether on the Output of Urine by Nephritic Animals.

A. S. Wheeler: The Chemical Action of Light.

204th Meeting—March 18, 1913

William Cain: To Find the Equation of a Curve, having given certain Ordinates, y, and the slopes corresponding to these values.

H. W. Chase: Status and Problems of Present-day Psychology.

205th Meeting—April 17, 1913

J. A. Holmes: The Rescue Work of the Bureau of Mines.

206th Meeting—May 13, 1913

H. F. Reid: Glaciers.

Business Meeting—September 30, 1913

Election of officers:

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Permanent Secretary—F. P. Venable.

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207th Meeting—October 14, 1913

H. V. Wilson: The Biological Idea of the Individual and the Experimental Fusion of Embryos.

Collier Cobb: Report of the International Geological Congress Held in Toronto in August, 1913.

208th Meeting—November 11, 1913

William Cain: Stresses in Wedge-shaped Reinforced Concrete Beams.

W. C. Coker: Poisonous and Edible Mushrooms of Chapel Hill.

209th Meeting—December 9, 1913

W. DeB. MacNider: The Influence which is Exerted by the Age of the Animal in Determining the Severity of Certain Reactions.

Collier Cobb: Æolian Action in the Temiskaming, Niagara and Quarternary of Northern Ontario.

210th Meeting—March 17, 1914

C. S. Mangum: The Study of Morphology by the Reconstruction Method.

W. L. Jeffries: Relation of Color to Structure in Organic Compounds.

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211th Meeting—October 13, 1914

F. P. Venable: Modern Conception of the Atom.

A. H. Patterson: Demonstration of the Gyroscopic Monorail Car.

212th Meeting—November 10, 1914

W. C. Coker: Poisonous Mushrooms.

T. F. Hickerson: Farm Waterworks: Demonstration of the Hutchinson-Hickerson Overshot Waterwheel and Pump.

213th Meeting—December 15, 1914

C. H. Herty: 1. Isoprene from Commercial Turpentines. 2. The Effect of Resene on the Lathering of Soap Solutions.

Collier Cobb: Is the North Carolina Coast Subsiding? Illustrated.

215th Meeting—February 16, 1915

A. Henderson: Integral Equations. Trenholm's Discovery.

A. H. Patterson: Significant Peculiarities of the Solar System. Illustrated.

216th Meeting—March 9, 1915

F. P. Venable: Radioactivity and the Periodic System.

P. H. Daggett: The Wireless Installation at the University.

217th Meeting—April 27, 1915

W. M. Thornton: The Education Necessary to Fit a Young Man to Become an Engineer.

Business Meeting—October 5, 1915

Election of officers:

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Permanent Secretary—F. P. Venable.

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218th Meeting—November 9, 1915

A. S. Wheeler: Tea, Coffee and Cocoa.

J. G. Beard: The Collection and Cultivation of Crude Drug Plants in North Carolina.

219th Meeting—December 14, 1915

W. S. Franklin: Some Phenomena of Fluid Motion and the Curved Flight of a Baseball.

220th Meeting—February 7, 1916

E. A. Harrington: The Lumiére Process of Color Photography. Illustrated.

221st Meeting—March 14, 1916

A memorial meeting. In memoriam: Joseph Austin Holmes. Speakers: J. H. Pratt, F. P. Venable, K. P. Battle.

222d Meeting—April 18, 1916

Collier Cobb: Further Study of Zonation in the Chapel Hill Stock.

J. E. Smith: Petrography of the Diorites Near Chapel Hill.

Business Meeting—September 27, 1916

Election of officers:

President—T. F. Hickerson.

Vice-President—J. G. Beard.

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Recording Secretary—J. W. Lasley, Jr.

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223d Meeting—October 10, 1916

A. S. Wheeler: The Second International Chemical Exposition.

J. W. Lasley, Jr.: Some Elementary Vector Equations.

224th Meeting—November 14, 1916

W. C. Coker: Some Problems in Classification.

T. F. Hickerson: The Quebec Bridge. Illustrated.

J. W. LASLEY, JR.,
Recording Secretary.

THE NATURE OF THE INDIVIDUAL IN THE ANIMAL KINGDOM*

By H. V. Wilson.

I believe that many of us think of the animal body as too unique a thing, as something cut out, so to speak, from the world of matter in too fundamental a fashion. If we turn to the inorganic world we find, to be sure, individuals there—crystals, for instance; but we recognize that the individual crystal owes much of its characteristic detail to what we call accident; that is, the same matter which forms one crystal might have formed two, or, on the other hand, only a fraction of a larger one. Thus the crystal, as an individual, is something fortuitous and secondary. It is the substance of which it is composed and which determines the character of the crystal that is more important.

An analogous viewpoint, it seems to me, is the rational one with respect to animals. It is the specific substance rather than the individual mass that we are investigating when we study biology. It is the properties of dog-protoplasm, for instance, of dog-plasm as we may call it, or of sea-urchin plasm, etc., that we need to discover and classify. Individual animals concern us only in so far as they are lumps of specific substances, of species-plasms. The task of the biologist is then analogous to that of the chemist. Each must determine the properties of certain kinds of matter and the sequence in which they appear, that is, their relations of cause and effect.

My contention is, then, that biology deals at bottom with a group of excessively unstable substances, the protoplasms, the various kinds of living substance, both such as are found in nature and such as are experimentally producible. The distinctive properties of these substances as we know and learn them today, whatever their ulterior nature may be, do not fall in the established categories of physico-chemical phenomena, but reveal themselves as responses to stimuli, responses which express themselves in growth, differentiation, and

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reproduction, in the physiological processes of the body maintaining itself for a time as a concrete mass, and in the changes leading to old age and death, or in some of the lower forms leading not necessarily to death, but to a reversal of ordinary development whereby the body as a whole or in spots passes back into an embryo-like phase.

Some such point of view has in a measure long been held by many biologists. Spencer gives expression to it in his hypothesis of "physiological units" and his consideration of the nature of organic regeneration (1864-67). It is implied and in various passages distinctly maintained by Haeckel in his *Generelle Morphologie* (1866). It was presented with great directness and completeness by Mrs. E. A. Andrews in her remarkable book *The Living Substance* (1897). The histological side of Mrs. Andrews' book, original as it is, is equaled in importance by her treatment of the fundamental structure of protoplasm in relation to its biological properties (*cf.* Heidenhain, 1907, p. 493). In the addendum to this lecture other important references are given.

Nevertheless it seems to me that this way of looking at living things is too frequently obscured by the very facts that we amass, and perhaps also by the complex hypotheses which we invent. This conception of individual bodies as mere masses of specific substances is supported by a long series of discoveries, some old, some recent. I propose to describe a few of them.*

The kinds or grades of individual occurring in nature. Let us consider for a moment the kinds or grades of individual occurring in nature. An ordinary metazoan animal, hydra, earthworm, fish, man, is in technical language an individual of the second order, in that the body is here composed of multitudes of primary elements, the cells. The protozoa, amœba, for instance, are minute free-living forms, the body of any one of which is analogous to a metazoan cell. These, then, like the cells, are individuals of a lower grade than a hydra or a dog. They are individuals of the first order. Again we find, especially in the coelenterates, the group which includes the corals, sea-anemones, hydroids, etc., individuals of a higher order than those animals with which we are chiefly familiar. In these forms the first

*The illustrative diagrams given in the lecture are here omitted.

individual gives rise by budding or incomplete division to several, often to large colonies, the members of which remain connected and are mutually dependent. Such colonies may undergo a high degree of integration, as in the siphonophores. The "Portuguese Man-of-war," for example, which we all recognize as an individual animal, is yet anatomically a colony of forms, each comparable to a hydra. It is an individual of the third order.

We thus learn that the formal or morphological conception of the animal individual is one which varies with the group. In the protozoa the "individual" is one thing, in the vertebrates another, and in the siphonophores still another.

Propagation of animals from cuttings. Passing to the field of experiment, let us first consider the propagation of animals from cuttings. Such facts fall under the rubric of "regeneration," using the term in a wide sense.

In the protozoa, Stentor is especially favorable for experimentation. The animal is trumpet-shaped, with a greatly elongated "beaded" nucleus, and when expanded may reach one millimetre in length. It may easily be cut in pieces. If this is done, the pieces that contain portions of the nucleus remodel themselves into the characteristic shape and become individual Stentors (A. Gruber). Similar experiments have been performed on many protozoa.

In the sponges Cavolini (1785), and especially Oscar Schmidt, in the course of his studies on Adriatic forms (1862—), showed that if a single animal be cut in pieces, the pieces heal and become new individuals. Since his time various experiments made on a large scale, notably those carried on in recent years by the U. S. Bureau of Fisheries,* have demonstrated that the method is of commercial value.

The experiments of the Abbé Trembley on hydra are classics. Hydras are small fresh-water forms belonging to the group of coelenterates. The body is an elongated sac. The mouth surrounded by tentacles is at one end and opens into a digestive cavity. The body wall is made up of two layers of cells, some of which are muscular.

*A Practical Method of Sponge Culture. By H. F. Moore, Proc. Fourth Intern. Fishery Congress, 1908.

others nervous, others secretory, etc. Trembley showed in 1740 that if a hydra be cut in pieces the pieces become new hydras.

Within a year Trembley's experiments were followed by many others, and it was shown that marine polyps and star-fishes may be propagated in this way. Bonnet demonstrated (1741) that the method is applicable to forms as high as the earthworm family. He cut a fresh-water form, Lumbriculus, into several (three to fourteen) pieces, and found that almost all remodeled themselves into little worms. In recent years these beautiful experiments on the regenerative capacity of animals have been greatly extended and the phenomena subjected to close analytical study, in this country especially by T. H. Morgan and his students.

From such experiments we learn that the "individual" is not essentially unique. We cannot say of him, "He is there, or not there." For, being "there," with a stroke of the knife or scissors we make out of one, two. The interest attaching to such facts is great. Their significance for the conception of individuality is obvious.

Reduction-phenomena. Some of the phenomena classed under the head of "involution" or "reduction" are of importance for our inquiry, especially the notable discoveries of Driesch on ascidians and the facts that have been worked out on sponges. I restrict myself to the latter.

It has been shown (H. V. Wilson) on one of our common coastal forms (Stylotella, one of the monaxonida) that if the sponge be kept in confinement under conditions that are unfavorable and yet not immediately disastrous, the sponge body quickly gives up much of its structure. The apertures through which water enters and leaves the sponge close up, the system of canals ramifying through the body is suppressed in large measure, the skeletal arrangement is simplified, and the little chambers lined with flagellated cells which maintain the current of water necessary for a physiologically active life disappear, the flagellated cells becoming amœboid and creeping away into the general mesenchyme. All this appears in the light of a behavior that is useful. The sponge endeavors, so to speak, to protect itself against the bad water of the aquarium. If restored to good conditions at any time, differentiation quickly takes place and the body resumes its typical structure. But if the unfavorable conditions persist the sponge ceases to act as an individual. A large part of it

dies. Cells creep together in spots and form little masses easily distinguishable by their bright color. Microscopic study shows that in such masses the living tissue has passed into a simple phase, owing to which doubtless it is able to resist the environment. If now these minute masses are cut out and restored to well aerated sea-water, they quickly transform, each into a little sponge. Essentially the same facts have been made out on fresh-water sponges (K. Müller) and on calcareous sponges (O. Maas). The regenerative masses formed in this way are in many respects analogous to the reproductive bodies known as gemmules which are normally formed in the life cycle of many sponges. Much still remains to be learned of the relative parts played in their formation by the de-specialization of tissue elements and by phagocytosis on the part of amœbocytes. For us the experiments are interesting in that they show so plainly that the individual body may as a whole die, but remain alive in spots, the flesh here passing into a condition of unspecialized regenerative tissue (technically "totipotent").

In speculating as to the underlying events that go on in a sponge which thus abandons its individuality and breaks up into masses each capable of producing a new individual, we first ask ourselves what keeps a mass of cells together as an individual? It is apparently the constant exchange of stimuli between all the various parts of the body, to which this is due. If a part of the body is for one cause or another isolated from this traffic of stimuli, it dies or passes into the condition of regenerative tissue. Using the imagination a little, we may say that the cells cut off from the usual intercourse with one another tend to revert to the primitive condition of unspecialized bits of protoplasm capable of doing all things (totipotent). Some actually attain this low, but now useful, level. Such huddle together and form masses that succeed in resisting the unfavorable environment. With the return of a favorable environment the powers of such masses become active and they now transform themselves each into a new organism.*

*Wilson, H. V. "A New Method by Which Sponges May be Artificially Reared," *Science*, June 7, 1907; "On Some Phenomena of Coalescence and Regeneration in Sponges," *Journ. Exp. Zoology*, vol. 5, 1907; "Development of Sponges from Dissociated Tissue Cells," *Bull. U. S. Bureau of Fisheries*, vol. 30, 1911; "On the Behavior of the Dissociated Cells in Hydroids, etc." *Journ. Exp. Zoology*, Vol. 11, 1911. Child, C. M.: "Die physiologische Isolation von Teilen des Organisms, etc.," *Vorträge und Aufsätze u Entwmech. d. Organismen*, Heft 11, 1911.

Development from dissociated cells in sponges and hydroids. Allied to the forgoing is the phenomenon of the development of an organism from dissociated cells. We now know that sponges and hydroids may be broken up into microscopic bits of protoplasm most of which represent the cells of the original organism, and that such bits (dissociated cells), if given the opportunity, will reunite and form masses that transform into sponges or hydroids respectively (H. V. Wilson, K. Müller, J. S. Huxley, De Morgan and Drew, C. W. Hargitt). It is not impossible that this cellular behavior will be found to hold true of still higher organisms, at any rate of those which like polyzoa and ascidians include in their cycle of development asexual methods.

The treatment is simple. The animal is cut into pieces and these teased up into their constituent cells, or, better, pressed out through fine gauze. The cells stream through the gauze like sediment, and may be sown on glass plates, etc. They crawl together like the lymph corpuscles of a sea-urchin, forming plasmodial masses that exhibit amœboid phenomena. These metamorphose, as said. In the case of sponges, control of size is possible. That is, a large or small sponge may be made as desired. In the case of hydroids, size is not under control, for it is here a fixed specific character. The plasmodial masses may, of course, be made large or small, but the metamorphosis is carried out in such a way that hydroid tubes (and polyps) of a constant size are formed from them.

From such experiments it seems proper to conclude that the cells of the body, when their connections with one another are forcibly broken, pass into a generalized state in which they are attracted to one another. Thus they combine to form masses which then develop the peculiar features of that kind of protoplasm, viz., they restore one or several such animals. We may say that the particles of the species plasm fuse, and the mass so produced "forms out," metaphorically crystallizes out, at one or more centers. In such lower forms the permanency of the individual, its uniqueness, is obviously very secondary, while the species-substance is easily seen to be the primary, the fundamental thing.

Fusion and grafting in lower adults. In the lower forms to which reference has been made not only may the body be subdivided, and

so several bodies made out of a single one, but the opposite process may also occur, wherein two bodies or parts of two bodies fuse to form one. (*a*) Thus two adult sponges may grow together, forming a single sponge (Cavolini, Grant, Vosmaer). (*b*) Pieces of two or several hydras, hydro-polyps, or medusæ (Trembley, Wetzel, C. W. Hargitt, Miss Peebles, Miss King) may be fastened together with the resultant formation of a single individual. (*c*) Two earthworms may be divided, and the head end of one sewed to the tail end of the other (Joest). The wound heals, permanent union between the two pieces is made, and thus we have a new "individual" composed of parts of two former individuals. (*d*) In the experiments where dissociated cells of sponges or hydroids are made to fuse together and form new individuals, it matters not whether the cells which combine to form a new sponge or a new hydroid have come from one or from many former "individuals."

All such facts well illustrate the conception that the animal body is not something mysteriously unique and individualistic in a sense in which nothing else in the world is so. We see that its individualism is something not radically different from that of inorganic bodies, in so far at least as it is, like the latter, only the form which a specific substance assumes.

Regeneration and fusion in embryos of higher animals. With higher adults the case is different. We cannot cut a vertebrate animal, frog, or salamander, *e. g.*, in two and get two frogs or two salamanders. Nor can we sew the front end of one frog on the tail end of another and thus make a new frog. But what we cannot do with the adult can be done with the young. And here again, as in every nook and corner of biology, we get an application, an illustration, of the biogenetic law, of the great generalization that embryos of higher forms resemble lower adults. The resemblances are in part anatomical, or morphological as we say, and of these we know a great deal. But in part they are physiological, that is, the embryo of the higher form *will do* what it cannot do in the adult form but what the lower adult can do easily. Of these physiological resemblances we know little. What we have learned suggests how much of interest and value there is to be found out.

In the case of our own subject of inquiry—individuality—we learn that while the individuality of the higher adult is relatively fixed, that of the embryo is, in very many forms, on the same plane as that of the lower adult. Stating the facts more definitely, we may say that (*a*) The embryos of higher forms may be subdivided with the production of two or several organisms from a single one; (*b*) Two or several embryos may be fused together with the production of a single larger one; or (*c*) Components of two individuals may be combined to form a single body. With respect, then, to regeneration and fusion, such embryos behave much as do lower adults.

Let me briefly describe some of the concrete facts:

(*a*) If the sea-urchin egg be allowed to start its development and to divide into two cells, and if these two cells are now forcibly separated they will develop independently of each other. Each continues for a time to develop as if it were a half of a whole. Thus, instead of forming a sphere (blastula) it forms one half of a sphere. The half-sphere closes, however, forming a whole sphere (blastula). This invaginates to form the usual two-layered sac or gastrula. And this gradually develops into a pluteus, the characteristic swimming larva of the sea-urchin. The pluteus has the typical structure, but is, of course, smaller than the normal (Driesch).

The same experiment may be performed on vertebrates. In the newt (Triton), for instance, the egg of which is of considerable size, let us suppose that development has begun and the egg has divided into the first two cells. If now a fine thread be tied round the egg so as to separate the two cells, each develops into a whole but small larva (Herlitzka). If the egg be merely constricted, it develops not into two larvæ, but into a double-headed larva (Spemann).*

The eggs of very many other forms, medusæ, teleost fish, amphioxus, frog (under certain conditions) behave in a similar way. In certain groups, however, ctenophores (Driesch and Morgan), and especially the mollusca (E. B. Wilson, Crampton) and ascidians (Conklin), we now know through some of the most admirable of modern embryological investigations that the egg behaves in a different manner from the foregoing. Here, if the cells (blastomeres) of

*The cases in which other results follow are due to a different position of the first cleavage plane, and in no way impair the argument.

the segmenting ovum are separated, each does not give rise to a whole embryo, but only to a part of one. In general, we may say that a separated blastomere in these eggs tends to give rise to what it would have formed in the normal development. The protoplasm of the egg is specialized in that it is divided up into parts which in some forms are even optically distinguishable. These become the different cell groups that give rise to the great organs of the body. This organization of the egg is not, however, to be interpreted as meaning that the egg is a mechanism made up of parts that are distinct and self-propagative through a series of generations. For the cytoplasmic regions, "organ-forming substances," are not hereditary as such. What is hereditary is the habit of developing them. They are not present, or at least there is no reason for believing them present, in the young egg. They seem, on the contrary, to be formed anew in each individual development. They fall then in the class of differentiations made in the course of ontogeny. Their peculiarity is that they are formed so early. As to their precise nature, they may represent early specializations of the actual living substance, specializations which in extreme cases are not reversible (ascidians, apparently), or they may be largely forms of deutoplasmic material essential to the development of particular organs. The young egg in such species is comparable in this matter of individuality or integration with the egg of the jelly-fish or echinid.

Digression. Reversible specializations of the mass of specific substance constituting an egg are familiar. Thus the first two cells of the sea-urchin egg represent the two halves of a hollow ball, as is shown by their development immediately after separation. But this specialization into halves is later given up, and in consequence the half blastula becomes a whole. A similar reversal of specialization may be induced in the frog by turning the egg upside down in the two-cell stage (O. Schultze), or, as in Morgan's experiment, by first killing one of the blastomeres and then turning the egg upside down. Driesch visualizes such phenomena of "regulation" as due to a rearrangement of the particles of the protoplasm,* an explanation which is probably close to the truth.

**Analytische Theorie*, pp. 25, 149; *Science and Philosophy of the Organism*, vol. 1, p. 66 *et seq.*

(*b*) In the experiments of the preceding section the egg or embryo has been divided. Conversely, two eggs or young embryos (blastula stage) may be made to fuse. This has been shown (Morgan, Driesch, Goldfarb, DeHaan) to hold for the sea-urchin egg. Fusion results sometimes in the production of double monsters, viz., abnormal embryos showing some degree of duality. But in other cases the resulting individual (blastula, gastrula, pluteus larva) exhibits the normal unity of structure and is simply larger than the type. Fusion between eggs, embryos, or larvæ, with results essentially similar to the above, has been observed in sponges, medusæ, and nematode worms.

(*c*) The fusion of *parts* of different individual embryos to form one is strikingly shown in the case of the frog. Born discovered that if embryos in an advanced stage of development (just before or after hatching, when they measure in *Rana esculenta* about three millimetres in length) are cut in half, the head half of one embryo may be pasted to the tail half of another, and permanent union will take place. The composite embryos formed of components of two (former) individuals, grow, feed, and differentiate like the normal, becoming large tadpoles. One such, in Born's experiments, metamorphosed into a frog.* Owing to the ease with which the young embryos fuse at the cut surfaces, Born was able to combine them, or parts of them, so as to produce some very bizarre monsters which lived and grew for a surprising length of time. Harrison in similar experiments even combined components of different species, and thus obtained a frog the head half of which was made up of *Rana virescens* material, the trunk half of *Rana palustris* material.†

A like synthesis of one body out of components of two has been carried out by Crampton on moths. Crampton cut the pupæ in two and pasted parts of different individuals and, indeed, of different species, together. The components unite, although union is confined to the more superficial structures. The composite pupa metamorphoses into a moth, or when components are combined in bizarre fashion to what may be called a moth complex.

These results of experimental embryology throw light on the nature of "identical twins" and many of the "monsters," sometimes of such disconcerting aspect, of human embryology.

**Archiv f. Entw.-mech.*, 4, p. 393.

†*Archiv f. Entw.-mech.*, 7, pl. XI.

In conclusion, I may once more restate the generalization to which all the various kinds of facts referred to in the preceding lead up. It is that the animal body, our body, *e. g.*, is only the expression of the active forces of a specific substance, a specific protoplasm. Its uniqueness in the higher forms is deceptive. It falls then in the same great category of objects as a crystal. In making this plain, Haeckel and Spencer emphasized a thought of fundamental importance, the value of which is not diminished by the fact that the category is a wide one and therefore susceptible of continued division.

Addendum.

(1) A germ cell is then a lump of a specific substance, which under appropriate conditions will go through a certain cycle of changes. Out of harmony with this conception is Brücke's classic definition of the cell as "an elementary organism" (1861), recently supported by the late Professor Minchin, in opposition to the idea that it is a piece of a substance (1915). But the facts brought out by Whitman (1893), Sedgwick (1894), Mrs. E. A. Andrews (1897), Heidenhain (1907), and the data presented in the body of this lecture, show that cell formation in actual ontogeny is only a morphogenetic principle or method (*cf.* Sachs, 1882, p. 88; E. B. Wilson, 1902, and Heidenhain, *loc. cit.*, give the references to Sachs's later and more explicit discussions), that cells are only subordinate regions of the whole mass, and that the egg cell is potentially an organism, or two, or a fraction of one. Thus the implication of uniqueness in Brücke's phrase cannot be sustained. Cells between which transference of cytoplasmic material takes place (Mrs. Andrews, H. Spencer), which fuse with one another or break connection, and the nuclei of which are all alike as is shown by shifting them about (O. Hertwig, Driesch), are obviously only regions or free lumps of a substance.

The fixed individuality of the cell is emphasized in the preformation theories which represent the egg cell as a machine, as a compound machine, in fact, made up of little machines (determinants), each of which transforms itself into a particular kind of part (Weismann) or a particular part (His) of the adult organism. In Weismann's theory chromatin particles, in His' cytoplasmic particles represent the determinants. Weismann's theory is of course strictly pre-

formational in that the determinants are hereditary (persistent through the generations as such). His' theory also falls in the preformational class if we look on the germinal particles as hereditary, but not so if we regard them as differentiations made anew in each egg.

But as Driesch, O. Hertwig, Spencer, and many others have pointed out, the facts negative the idea that the egg cell or organism into which it grows is a machine. The power to restore amputated parts and the power of a part to develop the typical structure in its entirety, are widespread. Machines do not behave in this way, but substances (crystals) do. Moreover, there are probably no independently variable parts in the hereditary constitution of an organism. That is, no one character changes by itself, but the whole constitution changes (Spencer, 1898-99, vol. 2, p. 622). A machine made up of determinants would not behave in this way, but a substance would.

(2) But what is the nature of this lump of specific substance, the germ cell? Are its properties such that we cannot believe they are all material? Is there some extra-material force bound up in it, a teleological *entelechy* which sees the end to be reached, and directs the atoms and molecules towards that end? Is the chain of events that constitutes ontogeny a phenomenon so singular, and the facts of organic restitution so radically different from restitution in crystals, that with Driesch we must go outside of matter for an explanation, and acknowledge the presence of the "archæus, vital principle, *nisus formativus*," against the charge of incorporating which Spencer defends his theory of physiological units (Letter of 1868 in 1898-99, vol. 1)? There seems to be no reason for doing so. The objective question is, Are the phenomena orderly and predictable? If so, they are no more supernatural than anything else. They are only the reactions of higher forms of matter to the environment.

This appears to be the position of Driesch in his *Analytische Theorie* (1894). For while he here argues for the control of ontogenetic processes by a teleological power (p. 147 *et passim*) and expressly says that "self-regulation" (Roux) is a teleological power (p. 150), he nevertheless says also that it is analyzable into architectural and physical components (p. 154). This is manifestly treacherous ground to linger on.

(3) We may conclude, then, that the egg is a piece of matter with certain properties. It belongs in the protoplasms, "the organic compounds which we call living forms" (Haeckel, 1906 (1866), p. 140). In our study of these we move on parallel lines with chemistry (Hertwig, 1912, p. 155) in so far as both biology and chemistry seek to discover the properties of the *kinds* of matter. The properties of the protoplasms which concern biology are their responses to stimuli (W. K. Brooks, 1899). Physical and chemical knowledge of them is interesting chiefly as it contributes to a better understanding of what they can and may be expected to do and how they may be changed.

When biology has learned infinitely more about the peculiar properties of the protoplasms than is now known, and chemistry and physics have in like degree increased their power over unorganized matter, chemistry may synthesize some simple form of living substance, analogous perhaps to the "living granules" of recent histology (Heidenhain). Biology then, with the aid of the other sciences, may make these "living albumens" interact upon one another in such wise that adaptive artificial protoplasms result (*cf.* W. K. Brooks), the members of the series becoming more and more complex with continued combination. This is for the distant future.

(4) The concept that an organism is primarily made up of a specific plasm, and the germ cells are only small lumps of the plasm, provides in itself a sufficient working basis for many classes of investigations. The concept is noncommittal as to the fundamental structure of protoplasm in relation to its heritable properties, and is indeed independent of future discoveries in this field. It is used all the time today and will continue to be used whatever we may come to think of the significance of cell boundaries and intra-cellular parts.

(5) Nevertheless, we inevitably ask ourselves, Is the living part of a germ cell, the part which we designate a specific plasm, a single substance made up of like molecular complexes after the fashion of a high organic compound?

It is so conceived in Spencer's hypothesis (1864-67; 1898-99). Spencer pictures a specific protoplasm as made up of "physiological units," all alike and each endowed with the heritable properties of

the species. The units are in physiological continuity throughout the body, such that what affects one part of the organism affects the whole; and are molecular complexes intermediate between ordinary chemical molecules and the cells. The physiological continuity which Spencer postulates is obviously analogous to the continuity which exists in any molecular substance.

Nägeli's micellar hypothesis (1884) elaborates the essential idea of Spencer's theory. There is a specific plasm for every organism. It is made up of molecular complexes, the micellæ, which, however, are simpler than Spencer's units, for, unlike the latter they do not grow and divide. They are combined in a definite fashion to form a reticulum of cords which extends throughout the body. Every cord of this reticulum, representing a group of micellæ, is endowed with the heritable properties of the species. The specific plasm receives the useful name of idioplasm. Combined with it is a nutritive plasm.

Wiesner (1892) and various others, Heidenhain (1907), Fick (1907), Reichert (1914), have developed Spencer's fundamental concept of a specific plasm composed of ultra-microscopic molecular complexes capable of growth and division.

The field is confessedly a speculative one. The actual structure of the living substance in relation to the realization of its potential properties, viz., to the "organizing process" which it undergoes in ontogeny, is unknown to us. As Spencer points out, his hypothesis of constitutional units only represents a "way of symbolizing the process so as to enable us most conveniently to generalize its phenomena" (1898-99, vol. 1, p. 373).

In such theories no detailed correlation is established between the fundamental, invisible structure which is deductively concluded to exist, and the visible differentiations of cells. They leave to one side, for instance, the nuclear behavior which modern cytology has discovered. There is, however, no actual contradiction between such discoveries and this class of theory. For it *may* always turn out that all optically distinguishable cellular structures are only the more or less persistent, but in final analysis replaceable, products or differentiations of a uniform idioplasm. Nuclei, to be sure, in amitosis, and chromatin, sometimes perhaps chromosomes, in mitosis appear to pre-

serve an independence throughout the cycles of cell division. Nevertheless, there is during mitosis a great interchange of material between nucleus and cytoplasm, which may indeed be one of the chief uses of mitosis in contrast to amitosis. Perhaps at this time cytoplasmic and nuclear material intermingle and reciprocally give up certain temporary peculiarities which they have acquired since the last equilibration episode. The chromatin would thus start out periodically afresh in the prophase as pure and concentrated (whence its staining properties) idioplasm. This idea is in accord with the observed facts as to constancy in number and shape of the chromosomes in a specific plasm, these being specific characters like any others. It is again not in contradiction with the existence of special chromosomes (sex chromosomes, *e. g.*), which influence metabolism, and hence the course of ontogenetic differentiation, in a particular way. Such would fall in the category of early idioplasmic differentiations, permanent sometimes through several generations, or as long as useful, but always reversible or replaceable; made at various times and in various ways in different species; to be looked on as physiological organelles that are differentiated anew by the idioplasm when needed. This view is in harmony, I believe, with the known histological and physiological facts of sex-determination. It is the logical conclusion if, with Spencer, Nägeli, and Mrs. Andrews, we assume that the idioplasm of an organism is a continuous and uniform substance.

(6) On the other hand, is the living substance or idioplasm not strictly a single substance, but a mixture in definite proportions (to be compared with a standard building mixture, for example) of somewhat similar but permanently distinct materials, nuclear and cytoplasmic, which are related perhaps phylogenetically? This is the view of Heidenhain (1907, p. 61, p. 495), who regards all optically distinguishable protoplasmic structures as having arisen ontogenetically or phylogenetically out of the fundamental substance, itself homogeneous in appearance and composed of molecular complexes, protomeres.

(7) Or are we to look with O. Hertwig and Strasburger (1884) and so many biologists on the chromatin as the true species substance

or idioplasm, and on the rest of the cell as a characterless but living material, a nutritive plasm? Whatever we may think of such a sharp distinction, the facts of cytology indicate that the chromatin is idioplasmic, whether or no anything else is. It is even permissible to go farther and to view the chromatin in a nucleus as a compound of unlike parts which have not the nature of Weismannian determinants, but which coöperate somewhat after the fashion of the smaller molecules that make up a molecular complex. They thus together constitute a substance, "anlage-substanz" of O. Hertwig, in which are potentially seated the specific properties; these latter being dependent both on the intrinsic nature and the arrangement of the chromatin particles (Hertwig, 1912, p. 399). The analogy is obviously with stereochemistry.

Morgan in a series of investigations summed up in a stimulating book (1915) has especially developed the conception of the living substance just referred to. The unlike chromatin particles, designated "bioplasts" in Hertwig's theory, he identifies as the Mendelian "factors." He and his associates find that the results of their extensive and notable breeding experiments are explicable on the theory that the "factors" are arranged in a linear series in the chromosomes, and that corresponding ones brought together in consequence of the fertilization of the egg are finally separated after a period of close association, during which they may exchange places in the chromosome complex, and pass into different gametes. The ordinary Mendelian "segregation" and many intricate combinations of characters are thus explained.

(8) It is well known and has often been said that the path of discovery is strewn with discarded hypotheses that once were useful, but have served their time. Many people unfamiliar with scientific research misinterpret the situation. In some way they have acquired too high a respect for the deductively reached "explanation." This to them constitutes the greatest triumph of the mind, and discarded theories therefore seem to bear witness against science itself. Whereas, as we all know, the really great and enduring result of the work of science is veritable knowledge grouped and made accessible in the shape of generalizations.

In regard then to our subject, as in other fields, it is the objective facts, wherever the eye is keen enough to discern and the mind logical enough to state them, that will stand, whatever be the fate of any present-day theory as to the fundamental structure of the idioplasm, as to the way in which hereditary traits are represented in the germ cells (*cf.* O. Hertwig, 1912, p. 708).

(9) In Child's recent book (1915), incorporating the results of a long series of investigations, individuality is discussed from a standpoint different from that taken in the preceding lecture. Child deals with the difficult question as to *how* it comes that a germinal mass of protoplasm acquires the organization of an adult animal or plant. This question involves two: first, a phylogenetic one, how a plasm has come to have a particular set of biological properties; and, secondly, how the gradual organization which appears during the ontogeny is directed. In both cases a difference as to intensity of metabolism between regions of the mass is, he concludes, the chief factor. Axes are thus established along which metabolism grades down from high at one end to low at the other. Such "metabolic gradients" lead in phylogenesis to the axial differentiations of structure characteristic of an organism (piece of plasm); and in the ontogeny of a concrete mass to the orientation of the characteristic axes; thus in a fragment of planarian, a certain point of high metabolism becomes the head end.

Child, it may be added, conceives the organism, and germ cell, to be a mass of specific material (he designates it a "specific reaction system") the potencies of which are implicit in its physico-chemical constitution but not severally localized (p. 202).

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SOME ELEMENTARY VECTOR EQUATIONS

By J. W. LASLEY, JR.

§ 1. In the real plane it is often convenient to denote the points by number pairs. We agree that to every number pair there shall correspond a point. There are ∞^2 points in the plane. A relation connecting the coördinates selects ∞^1 of these, which lie on a certain locus. This relation may be expressed parametrically as,

$$x = \varphi(\mu), \qquad y = \psi(\mu).$$

The elimination of μ leads to

$$f(x, y) = 0.$$

§ 2. In the complex plane a point is denoted by a stroke or vector z from the origin to the point. Corresponding to every pair of numbers (x, y) there is a complex number $x + iy$, or z. If the x and the y are connected parametrically as in article one, we have,

$$z = x + iy = \varphi(\mu) + i\psi(\mu) \;\ldots\ldots\; (1)$$

which for various values of μ gives points on a locus in the complex plane. In what follows we shall mean by $\bar{z}$ the conjugate of z. Then,

$$\bar{z} = x - iy = \varphi(\mu) - i\psi(\mu) \;\ldots\ldots\; (2).$$

The elimination of μ from (1) and (2) leads to

$$f(z, \bar{z}) = 0.$$

§ 3. It is at times convenient to express

$$z = \varphi(t)$$

and

$$\bar{z} = \bar{\varphi}(t)$$

where by t we mean a complex $\cos\vartheta + i \sin\vartheta$ or $e^{i\theta}$, whose conjugate is its reciprocal and whose geometric significance is a turn, and by $\bar{\varphi}$ we mean that function obtained from

φ by changing every complex to its conjugate. These equations are in a sense analogous to those parametric equations given in article one, and t is a sort of complex parameter. The elimination of t leads to

$$f(z, \bar{z}) = 0.$$

§ 4. A right line in the real plane is given parametrically by

$$x = a + kb, \qquad y = c + kd$$

as in article two

$$z = (a + kb) + i(c + kd) = (a + ic) + k(b + id) = A - kB$$

where $A = a + ic$ and $B = b + id$.

Similarly

$$\bar{z} = \bar{A} + k\bar{B}$$

where $\bar{A} = a - ic$ and $\bar{B} = b - id$. $\bar{A}$ is the conjugate of A.

The elimination of k gives

$$z\bar{B} - \bar{z}B + \bar{A}B - A\bar{B} = 0,$$

or, more compactly,

$$c\bar{z} + \bar{c}z + d\bar{d} = 0$$

where c, $\bar{c}$, d, $\bar{d}$, are complex.

§ 5. The circle

$$x^2 + y^2 = a^2$$

is given parametrically by

$$x = a \cos \vartheta, \qquad y = a \sin \vartheta \ .$$

Now

$$z = x + iy = a \cos \vartheta + i \sin \vartheta = at$$

and

$$z = x - iy = a \cos \vartheta - i \sin \vartheta = a/t$$

eliminating t

$$zz - a^2 = 0 \qquad (a \text{ real}).$$

§ 6. Picard[1] makes use of the form

$$z\bar{z} + Az + \bar{A}\bar{z} + B = 0 \quad (B \text{ real})$$

as the equation of a circle in the complex plane. He uses this form to show that under the bilinear transformation

$$w = (az + b)/(cz + d)$$

circles are sent into circles. He makes no explanations of how the equation was got, but states that when the complexes are replaced by the sum of their real and imaginary parts the circle's equation in the real plane results. Now article three gives us a direct way of passing from this real plane form to the complex plane equation.

A circle whose centre is the point (a, b) has for its equation in the real plane

$$(x - a)^2 + (y - b)^2 = r^2,$$

or parametrically,

$$x = a + r\cos\vartheta \ , \qquad y = b + r\sin\vartheta \ .$$

Then $z = x + iy = (a + r\cos\vartheta) + i(b + r\sin\vartheta)$

$$z = (a + ib) + r(\cos\vartheta + i\sin\vartheta) = A + rt$$

also, $\bar{z} = \bar{A} + r/t$

eliminating t

$$(\bar{z} - \bar{A})(z - A) = r^2$$

or more compactly,

$$z\bar{z} + a\bar{z} + \bar{a}z + b\bar{b} = 0$$

which agrees with Picard's form since the product $b\bar{b}$ is always real.

§ 7. The ellipse

$$x^2/a^2 + y^2/b^2 = 1$$

is given parametrically by

$$x = a\cos\vartheta \ , \qquad y = b\sin\vartheta \ .$$

[1] Picard's *Traite d'Analyse*, page 462.

Then

$$z = a \cos \vartheta + ib \sin \vartheta$$

$$\bar{z} = a \cos \vartheta - ib \sin \vartheta$$

adding

$$z + \bar{z} = 2a \cos \vartheta$$

subtracting,

$$z - \bar{z} = 2bi \sin \vartheta$$

eliminating ϑ ,

$$b^2(z + \bar{z})^2 - a^2(z - \bar{z})^2 = 4a^2b^2$$

which when written

$$(z + \bar{z})^2/(2a)^2 - (z - \bar{z})^2/(2b)^2 = 1$$

has a fair analogy to the form of the hyperbola's equation in the real plane.

§ 8. The hyperbola

$$x^2/a^2 - y^2/b^2 = 1$$

is given parametrically by

$$x = a \sec \vartheta \ , \qquad y = b \tan \vartheta$$

So

$$z = \mathrm{a} \sec \vartheta + ib \tan \vartheta$$

and

$$\bar{z} = a \sec \vartheta - ib \tan \vartheta$$

adding

$$z + \bar{z} = 2a \sec \vartheta$$

subtracting,

$$z - \bar{z} = 2bi \tan \vartheta$$

eliminating ϑ,

$$(z + \bar{z})^2/(2a)^2 + (z - \bar{z})/(2b)^2 = 1$$

which has a fair analogy to the form of the equation of the ellipse in the real plane.

§ 9. If we wish to pass from

$$z = \varphi(t), \qquad \bar{z} = \psi(t)$$

to

$$f(z, z) = 0$$

by elimination, we find at times that the elimination is not easily made. In many instances replacing t by its value $\cos\vartheta + i\sin\vartheta$ gives for ϑ an easier elimination.

For instance

$$z = bt + 1/t.$$

Here the elimination of t is more involved than the elimination of ϑ from

$$z = (1+b)\cos\vartheta + i(1-b)\sin\vartheta$$

$$z = (1+b)\cos\vartheta - i(1-b)\sin\vartheta$$

which are equations got from the above by replacing t by $\cos\vartheta + i\sin\vartheta$. In fact, the elimination proceeds as in article seven and gives

$$(z+\bar{z})/4(1-b)^2 - (z-\bar{z})^2/4(1+b)^2 = 1$$

which we recognize as an ellipse.

§ 10. If we wish to pass from a complex plane locus

$$z = \varphi(t)$$

to a real plane locus

$$f(x, y) = 0$$

we may do so as in the following illustration.

The equation

$$z = b/t + t$$

of article nine may be written

$$x + iy = b/(\cos\vartheta + i\sin\vartheta) + (\cos\vartheta + \sin\vartheta)$$

or, since t and i/t are conjugates

$$x + iy = b(\cos\vartheta - i\sin\vartheta) + (\cos\vartheta + i\sin\vartheta)$$
$$= (1+b)\cos\vartheta + i(1-b)\sin\vartheta$$

equating the real and imaginary parts

$$x = (1 + b) \cos\vartheta \ , \quad y = (1 - b) \sin\vartheta$$

which gives an ellipse parametrically expressed, for the elimination of ϑ gives

$$x^2/(1 + b)^2 + y^2/(1 - b)^2 = 1$$

§ 11. In what precedes we have seen that when a curve in the real plane can be expressed parametrically we may pass to an analogous parametric expression of a curve in the complex plane. When the eliminations are practicable we can arrive at an equation

$$f(z, \bar{z}) = 0$$

in the complex plane, which corresponds in a way to the equation

$$f(x, y) = 0$$

in the real plane.

We have illustrated the way in which in special cases we may pass from the one to the other.

This opens up the field for an analytical geometry of the complex plane whose coördinates are z and $\bar{z}$, corresponding to the coördinates x and y of Des Cartes. In the foregoing we have investigated the forms for this new geometry which the well known curves: the right line, the circle, the ellipse, and the hyperbola take. Other plane curves might have been chosen and their equations got in a very similar manner.

§ 12. These principles considered here have an application in the theory of rolling curves. If we suppose one complex plane to move upon another complex plane in a prescribed manner, the points of each plane trace certain path curves in the other plane. It is not the purpose of this article to go further into that subject than to say that in the study of these path curves the foregoing methods are of incalculable use.

Chapel Hill, N. C.

THE FISHERIES OF NORTH CAROLINA†

By Joseph Hyde Pratt.

A new era was started in the development of the fishing industries of the State of North Carolina when the General Assembly of the State passed, on March 4, 1915, "An act to establish a Fisheries Commission and to protect the fisheries of North Carolina."*

This law, which is State-wide, is considered by nearly all who have investigated it to be the most efficient and best fishery law that has been passed by any State. Honorable William C. Redfield, Secretary of Commerce, in an address before the annual meeting of the National Association of Fisheries Commissioners on April 18, 1916, at Wilmington, North Carolina, said:

> "I have taken no little pride, gentlemen of North Carolina, in pointing out personally to the Governors of other States and to the legislators of other States the progressive and effective law that exists here—a good law which has put the State of North Carolina in advance of others to its own good and to its great honor. I know that it has had a marked effect upon opinion elsewhere; that it has put this State of North Carolina in a position of prestige and dignity and self-respect and of vision for the future, and of common sense as regards the children that are to come, which has made it honorable in the sisterhood of States in this country. The State of North Carolina has led the way in this respect, and others have shown it the flattery of imitation."

It is believed that this law will enable the State to build up its fishing industry to a point where it can be compared favorably with a similar industry in any other State.

The passage of this law was brought about only by a campaign of education throughout the whole State, in which the people of the western and central portions of the State were informed as to the value of the fisheries, what they should mean to the State, and that they belong just as much to the people of the west as to those of the east. Many subjects appertaining to the fisheries of the State were discussed at various meetings in different parts of the State, and

*Public Laws of North Carolina, chapter 84, Session 1915.

†Paper read before meeting of American Fisheries Society, October 16, 1916.

pamphlets and newspaper sketches were printed upon these same subjects. Among the most startling points that were brought to the attention of the people regarding the fisheries were:

1. That North Carolina instead of being first in the output of her fisheries as is warranted by the abundance of her inland waters, which are peculiarly adapted for the maintenance of commercial fisheries, now holds eleventh place among the Atlantic and Gulf States.

2. That the ascendancy of these other States, particularly Virginia, Maryland, Connecticut, and Louisiana, has been obtained entirely through the enforcement of such regulations as would allow a reasonable catch from their fisheries and would preserve a sufficient part of the fish, so that the supply of each succeeding year would steadily increase instead of diminish.

3. That the decrease in the North Carolina fisheries is undoubtedly due to very heavy fishing of all kinds of apparatus, and the violation of the laws that have been passed to regulate fishing. This applies to both fin fish and shell fish.

4. That the most noticeable decrease in North Carolina fin fish has been among her more valuable fish, such as shad and herring.

5. That the oyster industry of North Carolina was at such a low ebb that it was hardly considered in the discussion of the oyster industry of this country.

6. That instead of the fish industry being worth from $7,000,000 to $8,000,000 per year, it is worth less than $3,000,000 per year.

7. That instead of North Carolina supplying her home demand of fish and oysters she is obliged at the present time to obtain a considerable proportion of them from other States.

8. That the fisheries of North Carolina belong to the whole State, and that the citizens of the State at large should be interested in their preservation and perpetuation.

The people, when they realized the condition of the fisheries and that they do belong to the State as a whole, took up seriously the question of how to protect and conserve this valuable asset of the State. As this was largely a question of legislation, it was pointed out:

First, that the legislation must provide for an impartial, uniform and efficient enforcement throughout all sections of the State, in the interest of all the people of the State, and not to the temporary interest of the fishermen.

Second, that the enactment of rules and regulations governing the fisheries must be such that they will give the greatest liberty to the fishermen consistent with the development and conservation of the fish industry.

Third, that the closest and most cordial coöperation should exist between the State commission and the Federal bureaus, particularly in the planting of fish and oysters.

Fourth, that in the administration of the laws and regulations governing the utilization of the fisheries a great deal of consideration must be given to the opinions and supposed rights of the fishermen, but that when the commission had, after due deliberation, passed certain regulations, these must be enforced impartially.

On account of the varied conditions that exist in all fishing localities there must be considerable elasticity in the law. The commission should have the power to regulate. The recently passed North Carolina laws are superior to those of other States in this question of elasticity. In support of this I would quote section 21 of the law, which is as follows:

"Sec. 21. The Fisheries Commission Board is hereby authorized to regulate, prohibit, or restrict, in time, place, character, and dimensions, the use of nets, appliances, apparatus or means employed in taking or killing fish; to regulate the seasons at which the various species of fish may be taken in the several waters of the State and to prescribe the minimum size of fish which may be taken in the said waters of the State; and such regulations, prohibitions, restrictions, and prescriptions, after due publication, shall be of equal force and effect with the provisions of this act; and any person violating the provisions of this section shall be guilty of a misdemeanor, and upon conviction shall be fined or imprisoned at the discretion of the court: Provided, however, that if a petition signed by five or more voters of the district or community which will be affected by the proposed change is filed with the Fisheries Commission Board through the Fisheries Commissioner, assistant commissioners, or inspectors, asking that they have a hearing before any proposed change in the territory, size of mesh, length of net, or time of fishing shall go into effect, petitioning that they be heard regarding said change, the Fisheries Commission Board shall in that event designate by advertise-

ment for a period of thirty days at the courthouse and three other public places in the county affected, and also by publication in a newspaper of the county, if such is published in said county, for two consecutive weeks, the place at which said board shall meet and hear argument for and against said changes, and may ratify, rescind, or alter this previous order of change as may seem just in the premises; and, Provided further, that in making regulations the Fisheries Commission Board shall give due weight and consideration to all factors which will affect the value of the present investment in the fisheries, and that no changes in the existing laws which, if they should go into effect immediately, would tend to cause fishermen to lose their property shall go into effect until twelve months from the date that the change has been made by the Fisheries Commission Board."

While the North Carolina law has only been in operation a little over a year, yet we are beginning to realize that it was a very valuable piece of constructive legislation that the General Assembly of 1915 passed, and that splendid results are to be obtained under it. While it does delegate to a central body the control of the fisheries of the State, it is, in my judgment, the only way by which our fisheries can be conserved and increased. Previous local control has nearly wiped out the sturgeon industry of North Carolina and other States; it has greatly decreased the mullet industry by reason of the catching of under-sized mullets; was rapidly depleting the striped bass and black bass fisheries, and it has nearly destroyed the oyster industry in this State and in others. On the other hand, where there has been a central control of fisheries, there has been a general restoration of certain fisheries that had been nearly depleted.

In 1907 North Carolina, according to Dr. Hugh M. Smith,* was far advanced in all phases of the fisheries among the South Atlantic States, and the State exceeded all the others combined as regards the number engaged in fishing, the amount of capital invested and the quantity and value of the annual yield. This is the prestige that North Carolina formerly had, and we believe that the operation of the present law will bring this back to her. There are but few other States that have as large a population so entirely dependent on the water for a livelihood as North Carolina.

The fish fauna of North Carolina is very rich in both species and individuals, and this is due to its great variety of topography and its

*North Carolina Geological and Economic Survey, Volume II, page 407; 1907.

large shallow sounds along the coast. It is stated by Dr. Hugh M. Smith, U. S. Commissioner of Fisheries,* that among the prominent features of the fish fauna are:

(*a*) The abundance of certain anadromous fishes, whose numbers are scarcely surpassed in any other waters, the chief of these being the shad, the alewives, and the striped bass.

(*b*) The variety and abundance of suckers, minnows, and sunfishes in the fresh waters generally, and of darters in the headwaters of the streams on both sides of the Alleghanies.

(*c*) The occurrence in the sounds and along the outer shores of immense schools of mullet, squeteague, menhaden, blue-fish, croaker, spot, pig-fish, pin-fish, and other food fishes.

(*d*) The extension to the North Carolina coast of many species which are characteristic of the West Indies or Florida.

(*e*) A few species of the Atlantic coast reach their southern limit in North Carolina (such as the cod and tautog), or do not occur in noteworthy numbers further South (such as the white perch and striped bass).

Of the 352 species of fish recorded from North Carolina about 95 at present have commercial value. To these would be added oysters, clams, mollusks, scallops, crabs, shrimps, turtles and frogs, which would represent the fisheries of the State.

North Carolina has been noted particularly for its production of black bass, shad, alewife, hickory shad, striped bass, white perch, eel, sturgeon, mullet, squeteague, croaker, spot, Spanish mackerel, and menhaden.

There is given below a list of the commercial fishes, together with localities from which they are obtained:

STURGEON. *Acipenser oxrhynchus.*

This species has been almost exterminated in the waters of North Carolina, where formerly it was very abundant. It is probable that by radical measures to prevent further diminution in the supply of this fish it can be restored to something like its original abundance. Dare County now produces the greater bulk of the sturgeon placed on the market from this State.

*North Carolina Geological and Economic Survey, Volume II, page 1; 1907.

GAR PIKE. *Lepisosteus Osseus.*

This species is also known in North Carolina as long-nosed gar and bill-fish, and is one of the common fish in Albemarle Sound and Neuse River. It has been put on the market to a considerable extent as a food fish, and there has been some demand for the skin to be used in covering boxes, sword hilts, etc. As the meat of this fish is well-flavored and wholesome, there is no reason why it should not be used more generally as a food fish.

SEA CAT-FISH. *Galeichthys milberti.*

This cat-fish frequents the beaches, sounds and bays and is the most abundant of the salt water cat-fishes, and is put on the market to a limited extent.

SPOTTED CAT-FISH. *Ictalrus punctatus.*

This cat-fish is reported as abundant in the French Broad River in Madison County, where it is used as a food fish, and is known locally as blue-cat.

WHITE CAT-FISH. *Ameiurus Catus.*

This is one of the best of the cat-fishes, and is marketed to some extent in North Carolina. It is especially abundant in Albemarle Sound and tributaries, and also occurs less abundantly in the Neuse and Yadkin rivers.

YELLOW CAT-FISH; Common Bullhead. *Ameiurus Nebulosus.*

This cat-fish, which is the common bullhead, occurs abundantly in the western end of Albemarle Sound and in Pasquotank and Roanoke rivers. While it is marketed to some extent, it is not considered of any large value as a food fish.

BROWN CAT-FISH; Mud cat-fish. *Ameiurus Platycephalus.*

This cat-fish is found abundantly in branches of Haw River in Guilford County; in the Little Yadkin River, Rowan County; in Catawba River, McDowell County; St. Johns River, Burke County. Locally it is used largely for food, but very few are put on the market.

YELLOW CAT-FISH. *Leptops Olivaris* (Rafinesque).

Only in the waters of the French Broad River and its tributary, the Swannanoa River, which are in the Mississippi basin, has this yellow cat-fish been found. It occurs in these streams in some quantity, and locally is a food fish of some importance.

WHITE SUCKER; Sand Sucker; Common Sucker. *Catostomus commersonii.*

This fish is commonly found in the Catawba River in McDowell County, the French Broad and Swannanoa rivers, Buncombe County. It has also been reported from the Yadkin and Neuse rivers. In the French Broad section it is known as sand sucker. In these sections it is considered an important food fish.

RED-HORSE; Shiner; White Mullet. *Moxostoma Papillosum.*

This is one of the commonest suckers found in North Carolina, and has been reported from the Dismal Swamp to the Cape Fear River, and thence to Georgia. It is common in the Tar River, Edgecombe County; Neuse River, Wake County; Little River, Wayne County; Haw River, Guilford County; Catawba River, Burke County; and Yadkin River, Yadkin and Rowan counties. Locally it is valued highly as a food fish.

WHITE MULLET. *Moxostoma Album.*

This sucker occurs very abundantly in the Catawba River and is highly valued as an article of food. In size this species is one of the largest, reaching four pounds and over, and is called by the people along the Catawba River white mullet.

SUCKER. *Moxostoma Thalassinum.*

This species is reported by Cope to have been very abundant in the Yadkin River and used locally for food.

RED-HORSE; White Sucker. *Moxostoma Aureolum.*

In North Carolina this sucker only occurs in streams tributary to the Ohio, which are all west of the Blue Ridge. It is found principally in the French Broad River and Spring Creek, one of its tribu-

taries, Madison County. It is used locally as a food fish in that section, where it is known as the white sucker. Fish of this species have been reported to have been caught that weighed twelve pounds.

RED-HORSE. *Moxostoma Robustum.*

This species has only been recorded by Cope, who reported its occurrence in the Yadkin River, and that it was highly valued as a food fish by the people living along the river.

RED-HORSE; Golden Mullet; Golden-finned Mullet. *Moxostoma Crassilabre.*

This species is abundant in the Albemarle region, and the larger fish have considerable market value. At Edenton and Elizabeth City the trade name for this fish is golden mullet and golden-finned mullet. At Plymouth it is on the market as red-horse.

RED-HORSE. *Placopharynx Duquesnii.*

This sucker is the common "red-horse" of the rivers in the western part of the State, and is used as a food fish.

CHOBY; Shiner; Silvery minnow; Smelt. *Hybognathus Nuchalis.*

This species is found very abundant in Pasquotank and Roanoke rivers and in Albemarle Sound near Edenton. It is caught and utilized to some extent for a food fish.

HORNED DACE; Dace; Chub. *Semotilus Atromaculatus.*

This species is found chiefly in brooks and is widely distributed in the State, being known in the French Broad, Catawba, Yadkin, Deep, Neuse, Tar, Cape Fear, and Roanoke rivers and their tributaries. It is a fish of fair size, some weighing as much as four pounds, and although only a fair food fish, it is used to considerable extent locally.

ROACH; Shiner; Shad Roach; Golden Shiner. *Notemigonus Crysoleucas.*

This minnow is very common in all parts of North Carolina east of the mountains, and is found in still and sluggish waters, particularly in the basins of the Catawba, Yadkin, Neuse, Tar and Cape

Fear rivers. It is also very abundant in the Albemarle region, and is caught during the shad season in large numbers in pound nets and seines. It is used for food, but principally for home consumption.

CARP; German Carp; Asiatic Carp. *Cyprinus Carpio.*

The carp was introduced in North Carolina in 1879 and now it is well known in all parts of the State, but is most plentiful in the warmer and more sluggish lowland waters in the eastern part of the State. While the production of this fish is small, it is one of the commercial fishes, and is put on the market from a dozen or more counties in eastern North Carolina.

EEL; Common Eel; Fresh Water Eel. *Anguilla Chrisypa* (Rafinesque).

This common eel occurs as a migrant in all the streams of North Carolina east of the Blue Ridge, but is only fished for commercially in certain sections in the eastern part of the State, as in the vicinity of Beaufort, Carteret County; New Bern, Craven County; Oriental, Pamlico County.

CONGER EEL; Sea Eel; Ocean Eel. *Leptocephalus Conger.*

This eel occurs somewhat abundantly in the harbor about Beaufort, and in the Newport and North rivers. It has also been found in the salt water sounds. It reaches a very large size, and is an excellent food fish. This fishery is capable of considerable development.

TARPON; Silver Fish; King Fish. *Tarpon Atlanticus.*

Each season the tarpon visits the North Carolina coast and enters the sounds as far north as Croatan Sound.

GIZZARD SHAD; Mud Shad; Nanny Shad. *Dorosoma Cepedianum.*

This species is present in the larger coastal waters of North Carolina throughout the year, and is usually abundant in the sounds and streams at the time these shad are passing from salt water to fresh water. Although the flesh of this fish is not of specially good quality, yet there is a market for a certain amount of it, particularly in winter.

HICKORY SHAD; Hick; Jack; Ship Jack. *Pomolobus Mediocris.*

This species is common in the coast waters and rivers of North Carolina, and in the winter it is caught in large numbers in Pamlico and other salt water sounds. In late winter or early spring it ascends the streams to spawn about the same time that the branch herring are seeking fresh water. Although a much inferior fish to the common shad, it brings a fair price on the market and there is some considerable demand for it.

BRANCH HERRING. Alewife; Branch Alewife; Goggle-eye. *Pomolobus Pseudoharengus.*

The alewives are one of the most abundant food fishes inhabiting the rivers of eastern North Carolina, and this State has been the leading alewife State in the country. They occur most abundantly in Albemarle, Croatan and Pamlico sounds and Neuse River. While many of these fish are put on the market fresh, the principal trade is in the salted fish.

GLUT HERRING; Herring; School Herring; Blue Back; May Herring. *Pomolobus Aestivalis.*

This herring comes later than the branch herring and usually appears about the middle of the shad season, but spawns a shorter distance from the sea.

SHAD; White Shad. *Alosa Sapidissima.*

The shad has been the leading commercial fish in North Carolina, and extensive fishing is carried on for the shad in the Cape Fear, Neuse, Pamlico, Tar, Roanoke, Chowan, Pasquotank, and Perquimans rivers, and in Albemarle, Croatan, and Pamlico sounds. At one time the shad fishery of North Carolina exceeded that of any other State, but owing, however, to excessive fishing, this fishery has declined to a very marked degree. The industry, however, has begun to feel the effect of the protective legislation that was passed, and it is expected that this fishery will soon be at high tide again.

HAIRY-BACK; Thread Herring. *Opisthonema Oglinum.*

This fish sometimes is found in considerable quantity in Beaufort harbor. It has little or no food value, but has been utilized at some of the fertilizer factories, being taken in hauling for menhaden.

MENHADEN; Oldwife; Alewife; Fat Back Shad. *Brevoortia Tyrannus.*

This is one of the most valuable of the North Carolina fishes, although not used at the present time to any large extent as a food fish. It is caught chiefly for conversion into oil and fertilizer. The principal plants are located in the vicinity of Beaufort, Carteret County; and in the Cape Fear River, Brunswick County.

SMELT; Bait; Anchovy; Striped Anchovy. *Anchovia Brownii.*

This fish is very common in the Beaufort region, Carteret County. While at the present time but little use is made of this fish as a source of food, they do exist in sufficient abundance to support a canning industry. If carefully preserved in oil similar to sardines, the fish ought to meet with a good sale.

BROOK TROUT; Speckled Trout; Mountain Trout. *Salvelinus Fontinalis.*

This trout is more or less abundant in nearly all of the streams of the mountain region of the State, which afford excellent fishing. The trout streams represent one of the more valuable resources of the Southern Appalachian region, and the State realizes the need of keeping the streams well stocked with trout and protecting them in the interest of the anglers.

RAINBOW TROUT; California Trout. *Salmo Irideus.*

This trout is not native to North Carolina, but was introduced into various streams of the State as early as 1880. While it is not equal to the brook trout as a food or game fish, yet it is better adapted to warmer and more sluggish waters than the brook trout, and to the changed conditions in western North Carolina, due to cutting of timber, etc.

PIKE; Red-finned Pike, Jack, Pickerel. *Esox Americanus.*

This pickerel is found in many of the streams, swamps and lakes of North Carolina. It is caught and used to some extent as a food fish.

CHAIN PICKEREL; Pike; Red-finned Pike; Black Pike; Duck-billed Pike; Jack; Pickerel. *Esox Reticulatus.*

This species is common in the lower courses of the eastern rivers of North Carolina. It is found most abundantly about Albemarle Sound, and it is from this section that the greatest quantity of this fish is marketed.

OHIO MUSKALLUNGE; Jack. *Esox Ohiensis.*

This species was recorded by Dr. Jordan from the French Broad River near Asheville, where it was reported to be one of the food fishes of that section, being known locally as "jack."

GAR-FISH; Bill-fish; Doctor-fish. *Tylosurus Marinus.*

This fish is common on the North Carolina coast, and during the spring it enters the sounds seeking fresh water. It is caught to some extent by the fishermen of Albemarle Sound, but is utilized only to a limited extent as a food fish. It is a fish, however, that should be more generally eaten, as its flesh is very palatable.

FLYING FISH. *Cypselurus Speculiger.*

This fish inhabits the open seas, and has occasionally been seen at Beaufort. It is a very superior food fish and may become one of the commercial fishes of the State.

SILVERSIDE; Sardine; Smelt. *Menidia Menidia.*

This species is common on the North Carolina coast, and has been taken at Beaufort harbor in midwinter, indicating that it is a permanent resident. It is a palatable fish, and is large enough to warrant its being used as a food fish. At the present time little or no use is made of the fish for this purpose.

STRIPED MULLET; Mullet; Jumping Mullet. *Mugil Cephalus.*

Of all the salt water fish of North Carolina this is the most abundant and important, and this State has ranked second in the extent of the mullet fishery. There has been a practice of marketing undersized mullets and using the smaller ones for fertilizer purposes. This will tend to cut down the supply and may lead to the extermination of this valuable fish. The new Fisheries Commission has passed regulations prohibiting this practice.

Mullets are caught in every county bordering on the salt water, but the bulk of the yield comes from Brunswick, New Hanover, Pender, Onslow, Carteret, Pamlico, and Dare counties. The largest recorded North Carolina mullet weighed ten pounds.

WHITE MULLET; Silverside Mullet; Blue-back Mullet; Mullet. *Mugil Curema.*

This mullet is less numerous than the striped mullet, with which it is associated. It is usually not distinguished from the striped mullet by the local fishermen, and the two are marketed together.

LITTLE TUNNY; Bonito; Bolter. *Gymnosardo Alleterata.*

This species is very irregular in its appearance along the North Carolina coast, but has been caught in the ocean off Nags Head. While at the present time the fish is not regarded with any particular favor as food in North Carolina, yet it is one of the fish that may in time become a commercial food fish of considerable importance.

TUNNY; Horse Mackerel; Albacore. *Thunnus Thynnus.*

This fish, which frequents the North Carolina coast, has not been caught to any large extent, and although a first-class food fish, it is not regarded as such in this country. It is a large fish, and probably could be caught in quantity if a market could be provided for it, and thus make an important fishery in this country as it does in Southern Europe.

BONITO. *Sarda Sarda.*

This fish is caught to a limited extent in the waters of Carteret County, but no particular attempt is made to catch this fish in large

quantity as at the present time it does not rank high as a food fish on our markets. It is, however, an excellent food fish, but unless bled immediately after capture, it is apt to deteriorate. This is probably one of the reasons why the fish has not been more generally considered a good food fish.

SPANISH MACKEREL. *Scomberomorus Maculatus.*

The Spanish mackerel is the highest priced fish caught in North Carolina waters and is caught principally by the fisheries of Carteret, Pamlico, Hyde, and Dare counties.

KING-FISH; Cero; King Cero; Spotted Cero; Spotted Mackerel. *Scomberomorus Regalis.*

This king-fish occurs regularly in summer in Beaufort harbor, and is caught and used as a food fish. The fishermen do not make any distinction between this and the Spanish mackerel and cero.

CERO; King-fish. *Scomberomorus Cavalla.*

This species has been caught to some extent by the seine fisheries in Carteret County. On account of the fact that it does not have good keeping qualities, it is not regarded as a specially good fish to market fresh, but as a salted fish it is very good.

AMBER-FISH: Yellow-tail. *Seriola Lalandi.*

While but very little attempt is made at the present time to capture this amber-fish, it does occur off the North Carolina coast, and could be found in quantity if properly sought after. Some years ago it was caught off the beaches at Nags Head, Dare County. It has value as a food fish and could probably support a fishery.

CAVALLY; Olbacore; Albacore; Horse Mackerel. *Caranx Hippos.*

This species occurs off the North Carolina coast and was formerly caught in considerable quantities at Beaufort, but in recent years it has not been as abundant.

MOON-FISH; Sun-fish; Horse-fish. *Vomer Septipinnis.*

This fish occurs off the outer beach near Beaufort in the fall, and is put on the market to a limited extent.

GAFF-TOPSAIL POMPANO. *Trachinotus Glausus.*

This pompano has been caught to a limited extent, but does not rank high as a food fish, and but little attention has been paid to it. The principal catch has been at or near Beaufort.

POMPANO; Permit. *Trachinotus Goodei.*

This pompano has been captured to some extent off the shores of Hyde, Carteret, and New Hanover counties, but very little use however is made of it as a food fish.

POMPANO; Sun-fish. *Trachinotus Carolinus.*

This is one of the best of our salt water food fishes, and has been caught and put on the market from Carteret, Beaufort, and Pamlico counties. This fishery is capable of considerable development.

BLUE-FISH; Tailor; Green-fish; Skip-jack; Snapping Mackerel. *Pomatomus Saltatrix.*

This is one of the more important salt water fishes of the State. The principal fishing for the blue-fish is in Carteret, Dare, Beaufort, Craven, Hyde, New Hanover, Onslow, and Pamlico counties.

CRAB-EATER; Cabio; Sargeant-fish. *Rachycentron Canadus.*

This species has been caught to a limited extent off the North Carolina coast from Cape Lookout south, and a market has been found for them in many sections of the State. In some instances this fish has been sold as cero.

HARVEST FISH; Star Fish; Star. *Peprilus Alepidotus.*

In the vicinity of Roanoke Island, in Croatan and Pamlico sounds, and in Beaufort harbor, this fish is caught in considerable numbers and is considered an excellent food fish.

BUTTER-FISH; Butter-perch; Dollar-fish; Harvest-fish. *Poronotus Triacanthus.*

This fish is caught in considerable quantity in Beaufort harbor, Pamlico Sound, and at Cape Lookout. It is considered an excellent pan fish, and is marketed in some quantity in this State.

CALICO BASS; Strawberry Bass; Crappy; Speckled Perch; White Perch. *Pomoxis Sparoides.*

This fish is common in Albemarle Sound and tributaries, in Tar and Neuse rivers and other streams of the Coastal Plain region. It is also found to some extent in certain of the rivers of the Piedmont region. This fish ranks high as a game fish, and is also considered a good food fish.

FLYER; Mill-pond Perch; Sun-fish. *Centrarchus Macropterus.*

This species, although small in size, is used locally at Plymouth and other places as a food fish, and is caught to some considerable extent in the Roanoke, Neuse, and Tar rivers.

ROCK-BASS; Red-eye. *Ambloplites Rupestris.*

This bass is confined in North Carolina to the French Broad River and its tributaries. As a game fish this ranks high, and it is also a good food fish.

GOGGLE-EYE; Chub; Mud Chub; Red-eyed Bream; Warmouth; Red-eye. *Chaenobryttus Gulosus.*

This species is reported as common in all the streams east of the Alleghany Mountains, in Albemarle Sound and tributaries, and in the Cape Fear River. It is in the Wilmington markets practically throughout the year, although it is not caught in any great abundance.

LONG-EARED SUN-FISH; Red-belly; Robin; Yellow-belly. *Lepomis Auritus.*

This species has been found in some abundance in the Catawba, Yadkin, Neuse and Cape Fear rivers and Albemarle Sound. It is caught to a limited extent and marketed.

BLUE-JOE; Blue Perch; Blue-gill; Blue Sun-fish. *Lepomis Incisor.*

This fish is common in the creeks near Edenton and in Roanoke River at Weldon, and is sold in the local markets. This is the largest and finest of the sun-fishes and stands high as a game and food fish.

SAND PERCH; Robin; Robin Perch; Pumpkin-seed. *Lepomis Gibbosus.*

This is one of the commonest fishes and is very abundant in ponds and streams. It is caught in some quantity in Washington, Currituck, Camden, Dare, and other counties in the eastern part of the State, and put regularly on the market.

SMALL-MOUTHED BLACK BASS. *Micropterus Dolomieu.*

This species is known to occur commonly in the Neuse River near Raleigh; Little River at Goldsboro; Swannanoa River near Asheville; and Spring Creek near Hot Springs. It is one of the best game fish, and it is also a good food fish.

LARGE-MOUTHED BLACK BASS; Welshman. *Micropterus Salmoides.*

This bass is found to a limited extent in the mountain region of North Carolina, but it is a fish of the Piedmont Plateau and Coastal Plain regions. It is especially abundant in Currituck Sound and in tributaries of Albemarle Sound. The large-mouthed black bass industry has been larger in North Carolina than in any other State, and Currituck Sound produces about three-fourths of the total yield.

WALL-EYED PIKE; Pike Perch; California Salmon; River Trout. *Stizostedion Vitreum.*

The pike perch fishery has not been developed to any large extent in North Carolina, although its range covers a large part of the State, having been found in the French Broad River and in many rivers of the Coastal Plain region. This species ranks high as a game fish, and is also considered a splendid food fish. If this fish was cultivated, it could probably be made an important industry in certain parts of the State.

RED-FIN; Yellow Perch; Englishman; Raccoon Perch. *Perca Flavescens.*

The yellow perch occurs rather abundantly in the fresh water streams and sounds and lakes of eastern North Carolina. It is a

good food fish and has been put on the market to some extent. It is also caught in large quantities by anglers. In North Carolina the largest catch comes from Currituck County.

STRIPED BASS; Rock-fish; Rock. *Roccus Linaetus.*

This is one of the largest and best of the fresh water fishes, and is found in many of the fresh water streams of eastern North Carolina, being especially abundant in the Albemarle region. This State leads nearly all the others in the quantity of striped bass caught, the most extensive catch coming from Dare County. The other counties marketing large quantities are Currituck, Chowan, Bertie, Martin, Halifax, Washington, Beaufort, and Craven.

PERCH; White Perch; Silver Perch. *Morone Americana.*

This fish occurs in the fresh, brackish, and salt waters of eastern North Carolina, being especially abundant in the Albemarle Sound region. In Currituck Sound it exists in greater abundance than any other commercial species. It is also found in quantity in New, Neuse, and Cape Fear rivers. Commercially it is more valuable than the yellow perch.

SEA BASS; Black Fish; Bass. *Centropristes Striatus.*

This sea bass, which in North Carolina is called black-fish and bass, occurs in abundance off the coast of North Carolina, and is caught for market in various sections. This fishery should be increased to a considerable extent, and at a good profit. The greater portion of the catch of this fish is from Carteret and New Hanover counties.

RED SNAPPER. *Lutianus Blackfordi.*

This important food fish has not been found in any great abundance on the grounds lying off the coast of North Carolina, except in the extreme southeastern portion off Cape Fear, where certain banks are known as "snapper banks."

PIG-FISH; Hog-fish. *Orthopristis Chrysopterus.*

This fish is one of the commonest of the food fishes of the North Carolina coast, occurring as it does in all the sounds and salt water

estuaries as well as on the outlying banks. It is one of the leading food fishes of the State, and is caught most extensively in the Beaufort region, Carteret County; and Pamlico Sound, Hyde County; and on the coast of New Hanover County.

SNAPPER; Grunt. *Haemulon Plumieri.*

This species undoubtedly occurs regularly on the various banks lying off the North Carolina coast. It is caught in some quantity off the coast of New Hanover and Brunswick counties, and marketed in Wilmington, where it is known as "snapper." There is a good opportunity of developing this fishery to a much greater extent.

GRUNT; Tom-tate; Red-mouthed Grunt. *Bathystoma Rimator.*

This red-mouthed grunt, which is abundant at Charleston, South Carolina, should be common along the southern part of the North Carolina coast.

SCUP; Pin-fish. *Stenotomus Chrysops.*

This scup has not been caught in very large quantity on the North Carolina coast, and no distinction is made by the fishermen between this fish and the southern scup or porgy (*Stenotomus Aculeatus*).

SOUTHERN SCUP; Porgy; Long-spined Porgy. *Stenotomus Aculeatus.*

This species should be found at Cape Fear, Beaufort, and other points.

ROBIN; Sailor's Choice; Pin-fish. *Lagodon Rhomboides.*

This fish is exceedingly abundant at Beaufort, Cape Fear, and elsewhere on the North Carolina coast, where it is known as pin-fish and robin. It was formerly thrown away but is now becoming a commercial fish and is marketed in some quantity in this State, principally at Wilmington.

SHEEPSHEAD. *Archosargus Probatocephalus.*

This species occurs in all the bays and estuaries of the North Carolina coast, although nowhere is it found in very great abundance, Carteret, Dare, Beaufort, and Pamlico counties producing the greatest yield.

SQUETEAGUE; Trout; Weak-fish; Sea Trout; Gray Trout; Summer Trout. *Cynoscion Regalis.*

This species is abundant along the North Carolina coast, but not in as large numbers as the spotted trout, and, like it, is present almost throughout the year.

SPOTTED SQUETEAGUE; Speckled Trout; Sea Trout; Trout; Spotted Weak-fish; Southern Squeteague; Black Trout; Salmon Trout. *Cynoscion Nebulosus.*

This fish is very abundant in North Carolina, and from an economic standpoint is the principal member of the drum family.

YELLOW-TAIL; Perch; Silver Perch; White Perch; Yellow-finned Perch; Sand Perch. *Bairdiella Chrysura.*

The yellow-tail abounds in the North Carolina sounds, estuaries and salt waters generally from early spring to late fall. Although a small fish, it makes an excellent pan fish, comparable with the spot, and could be made of some considerable economic value.

SPOT. *Leiostomus Xanthurus.*

The spot is very abundant in the sounds and other coastal waters of North Carolina, and in certain seasons enters perfectly fresh waters. North Carolina spots find a ready market in Baltimore, Washington and other cities.

CROAKER; Crocus; Hard-head. *Micropogon Undulatus.*

This is another one of the common food fishes of the North Carolina coast, being found in nearly all the sounds, estuaries and inlets and on the outer shores. The croaker is caught along the entire coast and has become one of the very salable species.

DRUM; Red Drum; Red-fish; Spotted Bass; Channel Bass. *Sclaenops Ocellatus.*

The red drum is one of the larger and more valuable of the food fishes, but as a fishery it has not been developed to as great an extent as it should be. This fishery is most extensive in Carteret County, but the fish are also caught in the Cape Fear region and about Roanoke Island.

SEA MULLET; King-fish; Carolina Whiting; Round-head; Whiting; Sea-mink. *Menticirrhus Americanus.*

This fish is abundant about Roanoke Island, Pamlico Sound, around Cape Lookout, Beaufort harbor, and Cape Fear. This fish is of exceptionally good quality, and at times commands a fancy price.

KING-FISH; Sea Mullet; Sea-mink; Whiting. *Menticirrhus Saxatilis.*

This species is usually not distinguished by the North Carolina fishermen from the preceding species, *Menticirrhus Americanus.* This fish is especially esteemed in New York and New Jersey markets. It is probable that if the king-fish were separated from the sea mullet or Carolina whiting, it would bring a better and more constant price.

SURF WHITING; Sea Mullet; Whiting; Silver Whiting. *Menticirrhus Littoralis.*

This whiting is rather common at Beaufort during the summer, and is marketed with the two preceding species.

BLACK DRUM; Sea Drum. *Pogonias Cromis.*

The black drum is less abundant than the red drum in North Carolina, and nowhere near as valuable as a food fish. It is very seldom shipped, and the principal use of it as a food fish is made locally by some of the fishermen.

TAUTOG; Oyster-fish. *Tautoga Onitis.*

This fish is not very abundant in North Carolina, and while it does not support a special fishery, it is some years caught in considerable numbers, especially in the waters of Beaufort harbor.

PORGEE; Spade-fish; Moon-fish. *Chaetodipterus Faber.*

This species is found on the North Carolina coast only in summer. Its flesh is of excellent quality, and there is considerable demand for it in the New York and Washington markets. The bulk of the catch has come from Craven, Dare, and Pamlico counties.

SUN-FISH; Head-fish; Moon-fish; Mola. *Mola Mola.*

This sun-fish, which attains a weight of fifteen hundred pounds, may become of economic value if it is determined that glue may be made from the abundant subdermal elastic tissue.

COD. *Gadus Callarias.*

At the present time cod fishing is of little or no importance in this State, but this species is known to occur regularly on the North Carolina coast north of Cape Hatteras, and it is possible that a winter codfishery of some importance might be established on the northern part of the coast. According to Dr. Smith, the fish will be found in greatest abundance on the off-shore shoals, and could be caught easily with lines or gill nets.

THE FLOUNDERS. Family *Pleuronectidae.*

There are seven flounders that are known to occur in the North Carolina waters or on the adjacent ocean bottom, and this fishery has become of considerable increasing economic importance in the State. The bulk of the production comes from Beaufort, Carteret, Dare, Hyde, and Pamlico counties.

FLOUNDER; Summer Flounder; Mud Flounder; Sand Flounder; Plaice. *Paralichthys Dentatus.*

The summer flounder is one of the most valuable of the flat fishes. Although a salt water fish, it is often caught in fresh water streams far from salt water.

SOUTHERN FLOUNDER; Flounder. *Paralichthys Lethostigmus.*

This flat fish is similar in size and habits to the summer flounder, and is more common in the coast and salt waters of North Carolina. It regularly resorts to fresh waters, and, according to Dr. Smith, is the only local flounder with that habit. It is common in the western end of Albemarle Sound.

FLOUNDER. *Paralichthys Albiguttus.*

This flounder is common around Beaufort and Cape Lookout and usually is not distinguished by the fishermen or merchantmen from the other flounders.

While some of the fishes enumerated above are only produced to a limited extent in this State, yet all of them do represent a portion of the natural food supply of the State, and many of them offer opportunities for much larger developed fisheries. Owing to the scarcity of certain of the more desirable fish, some of those which formerly had been considered of little or no value as a food fish have been found to be very palatable, stand transportation well, and when put on the market find a comparatively ready sale, although sometimes at rather low prices.

If North Carolina will cater to the trade and take particular care in the packing of the fish for transportation, in refraining from trying to put undersized fish on the market and keeping the fish in their own class, so that a certain trade name will always mean a certain fish, there is no reason why the fin fisheries of the State should not be greatly increased both in production and value. One phase of the work of the Fisheries Commission is along this line, and they are trying to have all the fish product from this State go out as North Carolina fish. With the increased railroad facilities in eastern North Carolina, it is now possible for the fisheries to ship their products into all parts of the country in competition with any of the other Atlantic States.

More attention is being given to the development of new fishing grounds, particularly to those off-shore on the submerged banks and in the surface waters; also to a more thorough exploitation of the old fishing grounds. Another means of increasing the industry which the State, through its commission, has recognized and is trying to carry out, is to increase the abundance of fish through cultivation. Still another means of increasing the industry, and which to the author is one of the more important ones, is the utilization of certain fishes which are now considered of little or no value. The U. S. Bureau of Fisheries has demonstrated conclusively that by a systematic advertisement fish which are known to be palatable and are a good source of food can be made to become a very marketable fish. This is well illustrated in the tile-fish, which, through the efforts of the Federal Government, has become a commercial fish of considerable importance. This Bureau has also been successful in bringing

the sea-mussel on the market as an article of food. Now they are considering a well known member of the shark family as a food fish, and personally I can see no reason why this particular member of the shark family, which unfortunately is known as dog-fish, should not become a staple article of food, marketed in steaks similarly as the sword-fish. The suggested commercial name is gray-fish.

In speaking of the future of the fin fish industry in North Carolina, Dr. Hugh M. Smith stated:*

"The fisheries may be expected to deteriorate—

"(a) Through failure of the State to provide prompt and adequate protection to those fishes which begin to show a decrease in abundance. The history of the sturgeon is an unmistakable indication of what will eventually happen to the shad, alewives, striped bass, and other species unless ample provision is made for the survival of a sufficient percentage of the annual run until spawning has ensued.

"(b) Because of unnecessarily wasteful methods, such as the capture of larger quantities of food fishes than can be utilized or disposed of to advantage and the useless destruction of large numbers of fishes of no present market value but of prospective importance.

"(c) Owing to careless methods of packing and preserving the catch, and to failure to keep abreast of the progress of the times in matters affecting the shipment and sale of fish."

The State is already taking cognizance of Dr. Smith's warnings (*a*) and (*b*), by the passage of the Fisheries Commission bill, which provides legislation for the protection of the fishes of the State and machinery for enforcing the laws. Also the Commission has the authority to regulate methods of catching and disposal of fish, which will prevent the waste in warning (*b*). The question of methods of packing and preserving the catch is receiving serious consideration, and improvement is being made along this line.

Thus there is every reason to believe that the fisheries of North Carolina will not only be maintained for an indefinite period, but will show marked growth in production and value.

OYSTER INDUSTRY.

North Carolina at the present time not only does not hold first place in the country in the oyster industry, but, as has been stated

*North Carolina Geological and Economic Survey, Volume II, page 412; 1907.

by the Oyster Commissioner of Virginia,* "Maryland is far behind Virginia in the laws and methods of administration of its oyster industry, while North Carolina is hardly in the running." Since that time conditions have changed, and North Carolina now leads in laws and methods of administration, although not yet in production. If the present law can remain in force, it will not be many years before the oyster industry of North Carolina will be equal to that of any South Atlantic State.

In the case of the oyster, as with certain of the fin fish, it will be necessary for the Fisheries Commission to insist that the oysters caught and marketed in this State shall be put on the market as North Carolina products. The Pamlico and New River oysters are equal to those caught in any other State in this country, and if the beds producing these oysters are cultivated and protected and the oysters vigorously advertised, it will not be long before the Pamlico oyster and the New River oyster will be as widely known as the Lynnhaven and the Blue Point.

The oyster canning industry is also capable of very large development in this State, and the Fisheries Commission is already taking steps to obtain legislation which will prevent the North Carolina canned oyster from being shipped as Virginia stock.

A very satisfactory law regarding the cultivation of the oyster was passed by the General Assembly of North Carolina,† but very little was accomplished under this law until the passage of the Fisheries Commission bill in 1915. Now the cultivation of the oyster is beginning to receive more serious consideration.

When we stop to consider that Pamlico Sound is as large as Long Island Sound, where something over 80,000 acres are under cultivation, and something like half as large as Chesapeake Bay, where approximately 20,000 or more acres are held for cultivation, it will be realized that the possibilities for oyster culture in this State are very large. The State has already proved through experimental work that the cultivation of the oyster can be carried on profitably in this State.‡

*"Virginia Fishing Industry," Oystermen and Fishermen, April, 1911, page 9.

†Public Laws of North Carolina, Chapter 871, Session 1909.

‡See Bulletin 15, North Carolina Geological and Economic Survey, 1907, on Experiments in Oyster Culture in Pamlico Sound.

Oystering is carried on in ten counties—Dare, Hyde, Beaufort, Pamlico, Craven, Carteret, Onslow, Pender, New Hanover, Brunswick. The greatest number of oysters, however, are taken from Hyde, Beaufort, Dare, Carteret, and Onslow counties.

ROUND CLAMS (Quahogs). The clam industry has never become of great importance in this State, although there are certain sections where it is capable of being developed to a considerable extent. A few experiments have been made regarding the cultivation of the clam which were rather successful. At the present time what clams are produced come principally from Brunswick and Carteret counties. This industry is capable of very large development in this State.

SCALLOPS. Only very small quantities of scallops have been gathered and marketed in this State, and these were obtained in Carteret County. No particular investigation has been made in regard to this phase of the fishing industry of the State, but it is believed that it can be developed to a very much greater extent than it is at the present time.

CRABS. The principal crab that is caught in North Carolina is the common blue crab, and nearly the entire catch is sold in the soft-shell stage. Very few people realize that there is any crab industry in this State, for the reason that at present practically all of the crabs are shipped by Christield, Maryland, packers, and usually go on the market as Maryland crabs. This industry is small but is capable of very large development, and if the plans of the Fisheries Commission can be carried out, it will be developed as a North Carolina crab industry. The crabs that are marketed are taken generally in Carteret County, although a good many are caught in Dare County around Roanoke Island. Although crabs are caught for local use in nearly all of the salt water counties, very few are put on the general market except from Carteret.

SHRIMP. The shrimp industry is confined to Brunswick, New Hanover, and Pender counties, the two former having the larger production. Little thus far has been done to develop this industry, but measures have been taken by the Commission to protect it and prevent its wasteful destruction.

REPTILIAN WATER RESOURCES. Of the reptilians there occur in North Carolina alligators, green and other sea turtles, diamond back

and other terrapins, and frogs. Of these the terrapin and frog are to be considered of commercial importance. A series of experiments were conducted in regard to the cultivation of the diamond-back terrapin, which proved successful,* and already one company has been organized and is carrying on the cultivation of the terrapin at Beaufort, North Carolina. The diamond-back terrapin is taken in small numbers about Roanoke Island and on the marshes of Beaufort harbor.

Frogs are hunted and marketed to a limited extent in Pasquotank and Camden counties.

The above will give some idea of the fishing resources of the State, which it is believed will in the near future be worth, instead of a few million, seven or eight million dollars per year to the State.

In closing I wish to say a word in regard to the cultivation of fishes in North Carolina, inasmuch as this State was one of the first to take up artificial propagation of fishes. I believe that the State can make no better expenditure of funds in connection with the fishing industry than in systematic fish culture, and I believe further that it is the duty of the State to establish and maintain several small hatcheries to assist in the replenishment of certain desirable fishes in our upland as well as lowland streams. This State has had the hearty coöperation of the Federal Government in the development of its fisheries, and the U. S. Bureau of Fisheries has maintained a shad hatchery at Edenton for a great many years.

With the passage of the Fisheries Commission Act, which should insure the enforcement of laws and the protection of the fish, there is still more reason for an increased number of hatcheries in this State, and greater coöperation of the State Commission with the U. S. Bureau of Fisheries. It is to be hoped that the two commissions will take up the artificial propagation of the sea mullet, spotted squeteague and other valuable salt water species, in addition to the cultivation of the brook trout, rainbow trout, small-mouthed black bass and spotted cat-fish for the mountainous regions, and the large-mouthed black bass, strawberry bass, and various sun-fishes for the lowland waters.

*Cultivation of the Diamond Back Terrapin, Bulletin 14, North Carolina Geological and Economic Survey, 1906.

SOME KNOWN CHANGES IN THE LAND VERTEBRATE FAUNA OF NORTH CAROLINA

By C. S. Brimley

This paper is an attempt to bring together in one place what data is in the possession of the author, relating to the changes undergone by the land vertebrate fauna of North Carolina, since the coming of the white man.

I. Mammals.

1. American Buffalo (*Bison bison* L.). "Originally ranged over much of western North Carolina, but exterminated about 1760." (Oberholser.)

2. American Elk (*Cervus canadensis* Erxl.). "Occurred in colonial times at least till about the year 1750." (Oberholser.)

3. Southern Beaver (*Castor canadensis carolinensis* Rhoads). Formerly more or less common throughout the state as evidenced by the frequent occurrence of the names "Beaver Creek" or "Beaver Dam Creek," but now nearly or quite extinct. Five specimens were collected for the State Museum in 1897 on the Dan River, near Danbury in Stokes County, and there is one in the museum which was collected near Weldon about 1884. In 1903, while collecting data for a list of North Carolina mammals, I received the following replies to my questions concerning beavers: "Not very common in Bertie County." (T. A. Smithwick.) "Very scarce, but a few" (in Buncombe County). (N. A. Fain.) "Rare; some few in Beaver Swamp in north Guilford and south Rockingham counties." (J. H. Armfield.) "Forsyth County, very few; some along Yadkin River." (K. E. Shore.) In 1905 Oberholser says of this species in western North Carolina: "Formerly occurred near Asheville; extinct in Pisgah Forest."

4. Roof Rat (*Mus alexandrinus* Geoff. St Hil.). Introduced from the Mediterranean region, probably during colonial times, and apparently till recently the common house rat of the State, at least in the interior. Disappeared from Raleigh about 1908 or 1909 and replaced by the brown rat. In the neighborhood of my own residence

the roof rats disappeared before I knew that there were any brown rats in Raleigh. Oberholser states that in the western part of the State it is apparently of rather recent introduction, and that specimens were taken in Pisgah Forest (Pink Beds) at 3,300 feet in August, 1904.

5. Brown Rat, "Wharf Rat" (*Mus norvegicus* Erxl.). Known to have been common near Beaufort in 1871 (Coues), and to have occurred at New Bern in 1884 (H. H. Brimley). First taken at Raleigh in March, 1909, and became the common house rat of that locality within two years. We heard that it overran Kinston a few years previously.

6. Gray Wolf (*Canis mexicanus nubilis* Say). Dr. Merriam in 1887 (Remarks on Fauna of Great Smoky Mountains) mentions the wolf as still occurring in our mountains, while Rhoads in 1895 (Mammals of Tennessee) mentions one as having been seen in 1883 near the Cloudland Hotel on the top of Roan Mountain. In 1903 I was informed that wolves still occurred sparingly in Graham, Cherokee, Buncombe, Caldwell, Yancey, and Watauga counties, and Dr. C. Hart Merriam wrote me about the same time that during one of his visits to Roan Mountain (in 1887 or 1892 ?) a den of wolves was discovered there and the young captured. Lastly, in May, 1912, while at Sunburst in Haywood County, I was informed by Mr. Eli Potter, woods superintendent of the lumber company operating in that region, that wolves were extinct in the mountains; that a band had committed depredations on stock some twenty-five years previously (about 1887), and that in consequence the people had joined together and killed out every one. Another man, a teamster, who was standing by at the time, agreed with him, and stated further that in the same year a litter had been raised near Highlands, but every one was killed. On the other hand, a few days before, another man, evidently only an ordinary mountaineer, had told me that wolves had been nearly exterminated, but were then slightly on the increase. Mr. Potter flatly contradicted this, saying no wolves were left in the mountains.

7. Southern Weasel (*Putorius noveborabensis notius* Bangs). This species appears to be at least somewhat more common at Raleigh

than in former years, as from 1884 to 1907, during most of which period I was on the lookout for mammals, I only came across two specimens, while from 1908 to 1916 I have known of at least a dozen being taken, although not on the lookout for them.

8. PANTHER (*Felis cougar* Kerr). About 1900 my brother and myself were informed by Mr. Walton E. Stone that a panther had been killed near Rose Bay, in Hyde County, shortly before the Civil War; and in May, 1908, while at Lake Ellis in Craven County, I was told that one had been killed below New Bern about the same time or a little later. In both cases the animal was described as much larger than a wildcat, and as having a long tail. Recently my brother, H. H. Brimley, Curator of the State Museum, has informed me that he was told by a Mr. Vyne of North Wilkesboro that the latter had killed one in the Lake Ellis region somewhere about 1885. Oberholser states in 1905 that "The skin of one said to have been killed by a Mr. Drew near Highlands, about 1886, was recently seen there by Mr. R. G. Murdoch."

. . . .

Among other mammals, the deer, bear, and wildcat, once distributed throughout the State, are now confined to the mountains of the western section and the swamps of the coastal plain, in which latter section deer are still quite plentiful in many places. The coon or raccoon is getting scarce in the central portion of the State and its distribution in the near future will probably be similar to that of the three others just mentioned.

II. BIRDS.

1. COMMON TERN (*Sterna hirundo* Linn.). Coues in 1871 calls this bird very common during the migrations, near Beaufort, but in the eighties, and in fact until the Audubon Society of the State was organized, it was very greatly diminished in numbers by the persecutions of the plume hunters. Under the protection accorded this species and others by the "Audubon Law," it has of late years been increasing again, so much so, indeed, that in June, 1909, Phillipp called it "very abundant" in Pamlico Sound.

2. LEAST TERN (*Sterna antillarum* Lesson). This species was

more abundant than the common tern in Coues' day, suffered more from the plume hunters, and has less completely regained its former numbers.

3. EGRET (*Herodias egretta* Gmelin). Coues in 1871 found this species only moderately common near Beaufort in late summer, and it still occurs and even breeds (in company with the next in one place in the coastal region), though almost exterminated by the persecutions of the plume hunters.

4. SNOWY EGRET (*Egretta candidissima* Gmelin). Coues in 1871 mentions it as occurring "most often in flocks of considerable size"; now, however, it is but seldom met with, though still breeding at one place in eastern North Carolina.

5. MARBLED GODWIT (*Limosa fedoa* L.). Abundant in Coues' day, now apparently much reduced in numbers, though in 1901 Bishop calls it a common migrant on Pea Island in May.

6. LONG-BILLED CURLEW (*Numenius americanus* Bechstein). In Coues' time it was "resident, abundant during the migrations"; now it seems to have totally disappeared from our coast. The last one known to have been taken was killed off Shackleford's Banks in 1885; but Pearson records seeing the species in May, 1898, near Cape Hatteras.

7. GOLDEN PLOVER (*Charadrius dominicus* Muller). Coues calls this species common during the migrations near Beaufort; now it seems to have entirely disappeared from our coast. Our last North Carolina record is one taken near Raleigh in the fall, about 1884, by W. S. Primrose.

8. PASSENGER PIGEON (*Ectopistes migratorius* L.). Once extremely abundant, now extinct. John Lawson in his History of North Carolina, published in 1714 in London, says of these birds in the Cape Fear region: "I saw such prodigious flocks of these birds . . . that they had broke down the limbs of a great many large trees . . . whereon they had chanced to sit and roost; . . . These Pigeons about sunrise when we were preparing to march on our journey would fly by us in such vast flocks that they would be near a quarter of an hour before they had all passed, . . . and so successively one after another for the greater part of the morning."

Dr. K. P. Battle, Jr., of Raleigh, has informed me that about 1875, while a student at Bingham School in Alamance County, he saw a flock of these birds that was about a mile wide, and that in 1878 he killed one out of a flock of three at Chapel Hill. H. H. Brimley saw three at Raleigh between 1881 and 1891, the last being on April 18, 1891; but the last known record for North Carolina is that of a female killed by the late J. S. Cairns near Asheville, on October 20, 1894.

9. CAROLINA PARROQUET (*Conurus carolinensis* L.). Now extinct in the State. Occurred on Roanoke Island in 1586, according to Thomas Heriot, who includes "parrots" in a list of birds of the island seen in that year, while Colonel William Byrd of Westover, Va., in 1729, states that parroquets visit North Carolina, but only during the warm season.

10. NORTHERN RAVEN (*Corvus corax principalis* Ridgway). (1) Coastal Region: In 1884 a mounted specimen, said to have been taken below New Bern, was in the possession of a local taxidermist of that place. On June 4 and 8, 1892, the species was seen by H. H. Brimley near Beaufort. Lastly in May, 1908, while at Lake Ellis, Craven County, I was told by several persons that they had formerly occurred, but that none had been seen for a number of years. (2) Mountain Region: Apparently still distributed through the mountains, our latest data being as follows: Roan Mountain, A pair apparently resident here in early June, 1911 (Bruner and Feild); Grandfather Mountain, Two or three seen every day during last week of June, 1911 (Bruner and Feild); Highlands, Five seen contending over a carcas on both May 13 and May 14, 1912, by Mr. S. C. Clapp, State nursery inspector, and Mr. H. C. Harbison, the botanist.

11. ENGLISH SPARROW (*Passer domestica* L.). Was introduced at Raleigh about 1879 or 1880, and by 1906 was present in all town localities, at least outside of the mountains. In 1905 and 1906 S. C. Bruner found none at Blowing Rock, but it had appeared there in 1907. In 1908 Mr. Sherman and myself found it still absent from Highlands.

12. SONG SPARROW (*Melospiza cinerea melodia* Wilson). Up to 1892 we had no records of this bird breeding anywhere in the State,

except on the northern half of the coastal banks, where it has been known to breed since 1870 (Coues); but since the former date it has been extending its breeding range southward in the mountains, till now it has become one of the commonest summer birds of the whole mountain region. Our knowledge of its progress is as follows: In 1892 three were seen frequently near Cranberry by Mr. Philip Laurent of Philadelphia during the summer of that year; in 1895 S. N. Rhoads found it common on Roan Mountain up to 3,500 feet; in 1902 Mr. T. G. Pearson saw two near Asheville in July (hitherto it had only been recorded as a winter visitor in Buncombe County by the late J. S. Cairns, up to his last known records (fall of 1894); in 1895 Oberholser records it as common in summer at Biltmore, and in the Pink Beds, Pisgah Forest; in 1906 S. C. Bruner finds it breeding at Blowing Rock; in 1907 Sherman observes the species in summer at Highlands and Hendersonville; in 1908 Sherman and myself found the bird in mid-May at Aquone, Highlands, and Blantyre; finally, in 1910, Sherman heard the species at Andrews in Cherokee County. Since then it has been found by Sherman, Bruner, Feild, myself, and others to be common in summer throughout Haywood, Buncombe, Madison, Mitchell, Yancey, Avery, and Watauga counties, and in that portion of Caldwell and Burke lying next to the mountains, all this area having been occupied by the species in the eighteen years from 1892 to 1910.

13. BLUEBIRD (*Sialia sialis* L.). Up to February, 1895, the bluebird was a common resident throughout the State, but in the first week of that month there came a period of sleet and snow which encased the bird's usual winter food (berries of various kinds) in a glittering sheet of ice, and the bluebirds, unable to obtain food, perished by thousands, and so complete and universal was the destruction that for some years afterwards it was quite an event to see a bluebird. Slowly, however, the species regained its numbers, and now is, so far as we can judge, about as common as formerly.

. . . .

Besides these more definite changes, I was informed a number of years ago, by Mr. R. B. McLaughlin, Jr., of Statesville, who was an observer of birds there during the early eighties, that when he first

paid attention to birds, the brown-headed nuthatch and hooded warbler were not known to breed near Statesville, but that a few years later both species had become regular breeders, and that the loggerhead shrike, which he found nesting there in his earlier years of observation, had vanished from that locality later on.

III. REPTILES.

1 YELLOWBELLIED TERRAPIN (*Pseudemys scripta* Schoippf). Some twenty-five years ago this species was only fairly common at Raleigh, and was about equal in numbers to the river terrapin (*Pseudemys concinna*). Now, however, the latter species has become much less common, while the yellowbellies have very greatly increased their numbers, so that now it is by no means a hard matter to get together fifty or a hundred at one time. It has also been taken at Greensboro, probably a recent extension of its range.

2. RIVER TERRAPIN (*Pseudemys concinna* Leconte). Frequents mostly running water, but even there seems to be now replaced by the preceding (at Raleigh).

3. TROOST'S TERRAPIN (*Pseudemys troosti* Holbrook). Mainly a Mississippi valley species, though I have had specimens from southwest Georgia, so that the taking of three specimens at Raleigh in 1914 and 1915 is of interest, and the future status of the species is a subject of conjecture.

. . . .

Another reptile, the banded rattlesnake (*Crotalus horridus*), although once ranging throughout the State, is now confined to the mountainous region of the west and the coastal swamps, while the alligator has been both reduced in numbers and restricted in range since early days; but we have no definite data in either case.

RALEIGH, N. C.

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THE AMANITAS OF THE EASTERN UNITED STATES.*

By W. C. Coker.

The observations on living plants for this study have been made, with few exceptions, in the environment of Chapel Hill, N. C., and all collections listed with numbers are from Chapel Hill and all distribution localities mentioned are from North Carolina unless the contrary is indicated. About thirteen miles from Chapel Hill is Hillsboro, where the Rev. M. A. Curtis did a large part of his work on fungi near the middle of the last century; and about eighty miles to the west is Winston-Salem, where Dr. Lewis David von Schweinitz was opening up the untouched field of American Mycology one hundred years ago. Records for Asheville (Beardslee) are taken from the Journal of the Elisha Mitchell Scientific Society **24**: 115. 1908, and from correspondence; for Blowing Rock (Atkinson) from the same Journal **9**: 98. 1892, and from the Cornell herbarium; for Flat Rock (Memminger) from correspondence; for the State at large or its districts (Curtis) from the Geological and Natural History Survey of North Carolina, Part III. 1867. The photographs and drawings have been made by me, and one of my students has inked in the pencil drawings. My niece, Miss Gladys Coker, painted the colored plate. Many of the spore measurements have been made by Mr. Totten and Mr. Neely, of the Botanical Department, but all the measurements accompanying the spore drawings have been made by me. I have thought it a convenience to students to add a borrowed description of the one species from the Eastern United States that seems to me good, but that I have not seen alive.

While many of the Amanitas are edible, others are so poisonous that one should take no chances with any of them. Even if con-

* Printed with the aid of a grant from the Elizabeth Thompson Science Fund of Boston, Mass.

vinced that a species is correctly determined and is reported edible one should always test it in small amounts before eating it in any quantity. The importance of caution is further emphasized by the fact that many of the Amanitas that are regularly eaten have been found by experiments on animals to contain small amounts of a deadly poison, and it is altogether possible that the amount of this poison may vary in different localities.

In determining the identity of the Berkeley-Curtis species, a none too easy task with inadequate descriptions and often poorly preserved material, it has been necessary for me to examine the Curtis Herbarium at Cambridge, and to Dr. W. G. Farlow I am under many obligations not only for the unusual courtesy of opening the herbarium to me in the summer, but also for repeated gifts of typical spore material. I am also greatly indebted to Dr. Geo. F. Atkinson, of Cornell, for much help during my early struggles with mycology, and for his generous treatment at all times during my several visits to Ithaca. Dr. W. A. Murrill, of the New York Botanical Garden, has given me much assistance for a number of years, and I have imposed too often, I fear, on his well-known good nature. It has been necessary to examine the types of Prof. Peck's species at Albany, and to Dr. Homer D. House, the State Botanist of New York, I am grateful for repeated loans of type plants and for other thoughtful courtesies during my visit to Albany. Professor Beardslee, of Asheville, has generously given me several European plants which have been of use in studying our species.

In order to present in a simple way the probable relationships of the species of Amanita I give below an outline of six groups that expresses their natural classification as it appears to me at present A fuller knowledge may considerably modify our ideas of these relations:

GROUP I. Volva large, sac-like, apically dehiscent, persistent, attached at very base of the stem, which is distinctly hollow and not at all bulbous; cap margin striate. Some edible; some said to be poisonous.

A. Cæsaria.
A. spreta.
A. recutita.

GROUP II. Volva sac-like, apically dehiscent, persistent (tending to break up in the southern form of *A. phalloides*), fused with the stem for some distance; stem solid, or, if slightly hollow, without a distinct central cylinder; cap margin even; veil thin and not friable. Probably all poisonous.

A. porphyria (?).
A. phalloides.
A. verna.
A. hygroscopica.
A. magnivelaris (?).
A. mappa.

GROUP III. Volva fused with the bulb, breaking up into warts on the cap, on the bulb forming flakes, lines, warts, or a truncate roll; stem stuffed or hollow, bulbous; veil thin, not friable; short gills truncate at the inner end. *Amanita muscaria* is poisonous, *A. cothurnata* possibly so and *A. gemmata* is harmless.

A. gemmata.
A. cothurnata.
A. muscaria.

GROUP IV. Volva breaking up completely into warts on the cap, and into obscure lines, fibers or scales on the stem base; veil thin, delicate, not friable; stem more or less bulbous, never completely hollow, and with no central cylinder; margin not striate or slightly so. Short gills not truncate at the inner end. Some, and possibly all, edible.

A. spissa.
A. excelsa.
A. rubescens.
A. flavorubescens.
A. Frostiana.

GROUP V. Volva remaining on the cap as firm warts, not noticeable on the stem base or only slightly so as lines. Veil very thick, compound, not friable, attached to the stem for some distance by strong fibers; stem solid, bulbous. No odor of chloride of lime. All edible.

A. solitaria.
A. abrupta.

GROUP VI. Volva remaining on the cap as firm warts or as a friable meal, scarcely noticeable on the stem base or appearing there as a friable meal, or (in *A. virosa*) forming a low cup; veil ample but very friable and fragile, usually breaking into pieces and falling away in expanding, mealy on the under side, attached to the very apex of the stem; stem solid, bulbous. Plants with a distinct odor of chloride of lime (old ham). Some edible, some perhaps poisonous.

A. strobiliformis.
A. chlorinosma.
A. Atkinsoniana.
A. virosa.
A. magniveláris (?).
A. cinereconia.

AMANITOPSIS

Usually solitary. Cap fleshy, fragile; glabrous or farinose, or with flat patches of the volva, usually striate on the margin. Gills free or just reaching the stem. Stem fleshy, fragile. Veil apparently absent; no annulus. Volva present, forming a sheathing cup at the base of the stem or a margin on the bulb, or falling into powder and disappearing. Spores white.*

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KEY TO THE SPECIES.†

1.	Volva forming an ample sheath at base of stem........................	2
1.	Volva breaking into rings or patches by the elongation of the basal part of the stem..*A. strangulata*	(2)
1.	Volva not forming a sheath or elevated rings or patches..............	3
2.	Volva a thin, long sheath collapsed against the stem; cap smooth, with or without volva patches.............................*A. vaginata*	(1)
2.	Volva more firm, not collapsed, often broken; cap with reddish scales ....*A. agglutinata*	(4)
3.	Plants with a margined bulb, stem very short.........................	4
3.	Plants without bulb, stem longer....................................	5
4.	Cap with small warts, gills broad........................*A. pubescens*	(6)
4.	Cap nearly smooth, gills narrow...............................*A. pusilla*	(7)
5.	Cap orange red..*A. parcivolvata*	(3)
5.	Cap ashy brown or gray, covered with gray meal.........*A. farinosa*	(5)
5.	Cap egg yellow..................................*Amanita gemmata*‡	

* This genus, it seems to me, is artificial and without systematic significance. Separated from Amanita by the absence of a single character, which is also frequently absent in accepted species of that genus, the species vary among themselves more than they do from certain corresponding species of Amanita.

† Figures in parentheses refer to the plant's number.

‡ This species of Amanita is often without a veil and may then be sought here.

1. **Amanitopsis vaginata** Bull.

PLATES 2, 3 AND 62.

This species is quite remarkable for its sharp variations in color. There are three pronounced color forms—(1) white, (2) tawny or chestnut or related colors, and (3) lead brown or mouse color. These have been called varieties (var. *alba*, var. *fulva*, and var. *livida*). While intermediate colors are not so common as the extremes, they are not at all rare, and as there seems to be little if any difference (but see note under 847) between these plants except color it would seem best not to call them varieties, but only color forms. The following description will include all the forms:

Tall slender plants that are rather common in woods, groves, borders, and shaded lawns. Cap 4-10 cm. wide, usually small in proportion to the height, when mature flat or the margin elevated, or sometimes remaining campanulate; surface smooth, shining, not viscid, at times with flat patches of the white volva; margin strongly tuberculate-striate; color showing a wide range, white, tawny, chestnut, cinnamon-buff, Brussels brown, capercine orange, lead or mouse color, with intermediate shades at times. Flesh soft, fragile, thin, whitish or tinted like the cap beneath the separable cuticle when the color is strong, only about 3 mm. thick in center; tasteless and odorless.

Gills moderately close, free or just reaching the stem, sometimes slightly decurrent by a line, about 3-5 mm. wide; color in the white form white, in the reddish form nearly white to light creamy brown and deeper brown where rubbed, in the gray forms whitish to distinctly drab.

Stem up to 19 cm. long, slender, nearly even or tapering upward, 3-9 mm. thick at top; surface more or less fibrous-flocculent, about color of gills, stuffed in center; base not bulbous, but surrounded by a thin or thickish, ample, sheathing volva which is usually collapsed against it, and is smooth, not flocculent on the outside and not slimy within. In most forms the volva is white, but in the gray forms it may be distinctly smoky on the inside.

Spores white, globose, very variable in size in the same and in

different plants, but showing no correspondence with the color forms.*

Edible.

Colored illustrations: Miss Marshall, Mushrooms, plate opposite p. 54; and Mycologia 1: Plate 7. 1909.

144. Battle's Park, fall of 1908. Tawny form. Spores 9.3-10 μ.
145. Battle's Park, near Dr. Battle's house, September 21, 1908.
321. Battle's Park, September 30, 1911. Tawny form.
414. Chapel Hill, November 7, 1911. Photo. Tawny form. Spores spherical, 6.5-9 μ.
455. Across road in front of Dr. Pratt's, September 28, 1912. Pure white; spores averaging about 8.4 μ.
479. Woods back of school house, October 3, 1912. Photo.
528. Woods southeast of school house, October 8, 1912.
690. Woods at top of Lone Pine Hill, May 29, 1913. Light mouse color.
700. Woods near Battle's branch, June 20, 1913.
729. In grass in arboretum, west side. Plants deep mouse color. Spores short elliptic, 7.4-9.2 x 9.2-11 μ.
732. Deep woods about one-third way down Lone Pine Hill, September 10, 1913.
763. Woods, Battle's Park, September 14, 1913. Two plants. Cap leaden brown, gills, stem, and volva lighter, but tinted with same color as cap.
764. Grove in front of Dr. Battle's, September 14, 1913.
807. Woods east of school house, September 22, and (the long one) Battle's Park, south of cemetery, September 24, 1913. Spores very variable, 6.6-14.8 μ.
847. Battle's Park, September 25, 1913. Photo. Two large plants, one 19 cm. high; cap only about 5 cm. broad, a beautiful Brussels brown color (Ridgway). Cap campanulate, not expanding completely as it does in the gray form. Gills nearly white, turning cream and drying yellow. Most of the plants of this variety seen this fall were of this color. One seen had more red in it. Spores very variable in size, 6.6-14.8 μ.
853. In deep pine woods southeast of brickyard in Tenny's meadow, September 28, 1913. Photo. A good many plants. Cap drab gray. Spores spherical, 8.3-12 μ.

* This great variation in the spores is rather uncommon in agarics. The spore size, and particularly the shape and surface markings (if any) are a great help in most cases in determining the species, and their neglect has led to many errors that could have been avoided. It should be borne in mind, however, that spores may vary in size in the same species under different conditions. Cotton has shown (Trans. Brit. Myc. Soc. 4: 298. 1914) that if the cap of *Stropharia semiglobata* be cut from the stem the spores successively formed decrease in size from 10 x 18 μ at first to 7 x 12 μ during the eighty-third hour. This he supposes due to the artificial conditions, but it is obvious that spores might vary considerably in natural conditions if moisture or food should be reduced.

1101. At foot of a large white oak in front of Gimghoul Lodge by street, July 9, 1914. Spores 7.5-9.4 μ.
1105. By path above Meeting of the Waters, along west branch, July 9, 1914. Photo. Mouse-gray.
1131. Oak grove near spring west of Dr. Hamilton's house, July 12, 1914. Photo. Tawny.
1559. In open mixed woods south of athletic field, June 19, 1915. Color Brussels brown.
1618. Sandy soil by Emerson's pond, July 16, 1915. Color a pale fleshy buff, between light buff and ivory yellow (Ridgway).
1793. Mixed dry woods, September 15, 1915. Color exactly tawny. Spores globose, 9-12.6 μ.
1813. Growing in dry woods northeast of graded school, September 17, 1915. These two plants were nearly white, but had a slight tint of mouse color.
1814. Deep woods, Tenny's ravine, September 17, 1915. Mouse gray with a tint of rufous.
1843. In deep woods by Battle's branch, September 20, 1915. Photo. White form. Cap pure white except for creamy center, 10 cm. broad. Spores variable, spherical, 8.5-11 μ in diameter.
2064. In grove near Dr. Battle's on campus, June 11, 1916. Photo. Mouse gray.
2100. Battle's Park, near east gate of campus, June 14, 1916. Photo.
2113. In grass under "Davie Poplar," campus, U. N. C., June 16, 1916. Cap cinnamon-buff on umbo, fading to pale straw on margin.

Blowing Rock. Atkinson.
Asheville, common. Beardslee.
Flat Rock. Memminger.
Common, woods and fields. Curtis.

2. **Amanitopsis strangulata** Fr.

PLATES 4 AND 62.

Cap up to 10.5 cm. broad, convex when young, expanded and slightly depressed in center at maturity, slightly umbonate, inherently radially fibrous and often cracked toward the strongly striate and slightly tuberculate margin, more or less covered with flattish, rather firmly adherent patches of the mealy, ashy-gray volva, or without these, scarcely viscid, dull or faintly shining. The color is not so variable as in *A. vaginata*, but we have found several color forms with intermediates, one smoky brown, exactly Saccardo's umber except in center which is sepia colored (Ridgway); another steel gray on margin and mouse gray in center, or a rather light lead-gray all over, the center darkest; another is almost

white, faintly creamy to pallid white; another is almost black in center, rapidly fading to mummy brown or sepia on margin. Flesh white, smoky near the surface, about 3.5-4 mm. thick in center, very thin in marginal half, colorless and with a flat, mild taste.

Gills free, moderately close, about 5-6 mm. wide, broad and rounded at margin, pointed at stem and barely reaching it, nearly pure white to light ash color, or light drab.

Stem about 8-17 cm. long, 6-7 mm. thick at cap, tapering upward, not bulbous, whitish or lighter than the cap, smooth or lightly fibrous and with the superficial layer often cracked, not at all lined at the top; base more or less incrusted with mealy patches of the friable and flocculent, mouse-gray volva, which usually forms a partial or complete ring one or two cm. from the base, but rarely a sac or complete basal incrustation. Flesh white, delicate, with a clear hollow which is about 2 mm. in diameter.

Spores white, usually spherical, but in some plants, as in No. 2201, subspherical to short elliptic, smooth, not so variable in size as in *A. vaginata*, usually about 8-11 μ in diameter,

Edible.

The volva is very peculiar and is different from any other species of Amanitopsis or Amanita. It breaks up into patches and particles of various sizes, which when quite fresh are slimy and whitish on inner side; parts that remain sticking to the stem are usually not at the base, but 1 cm. or more above it. The behavior is most like that of the volva of *Amanita Frostiana*, but it is more flocculent than in that species. From the volva of *A. farinosa* it differs in being more flocculent and less friable, and in the slimy inner surface and greater abundance. The volva is different both in structure and behavior from that of *A. vaginata*, which in other respects is very near. The volva of *A. vaginata* is nearly always white even in the deeply colored forms (in the gray form it is sometimes smoky) and forms a persistent ample membranous cup. The cap color is not so variable as in the last and the two plants seem distinct here, though undoubtedly very closely related. The structure and behavior of the volva is the only noticeable difference except that the spores are not so variable in size in *A. strangulata* and are

sometimes elliptic. Beardslee reports it from the mountains of West Virginia (Jour. E. Mitchell Sci. Soc. 24: 124. 1908), and he writes me that it is rare at Asheville. It has not been recorded heretofore from North Carolina.

489. Near path from east gate of campus south of Dr. Battle's, October 4, 1912. Photo. Spores white, spherical, 7-11 μ.

2102. Woods near east gate of campus, June 14, 1914. Photo. Spores pure white, smooth, spherical, 7.7-12.2 μ.

2196. Woods one-quarter mile southwest of Mr. Pritchard's, June 22, 1916. Spores spherical, 8-11 μ.

2197. Woods east of old graded school building, June 22, 1916. Color very peculiar in one plant, being a rather light lead gray all over, about drab gray in center and smoke gray toward margin (Ridgway), somewhat darker in center, a color that I have not seen in any of the numerous shades exhibited by *A. vaginata.* The three other plants were almost white, a faintly creamy and rather pallid white.

2201. Sandy woods road southwest of athletic field, June 23, 1916. Photo. Center almost jet black, rapidly fading to mummy brown or sepia on margin. One plant with large white volva patch covering about one-third of its surface. This structure was softly fibrous-flocculent, about like absorbent cotton and quite thin. At base of the stem the volva was not broken up as much as usual, but remained as a torn, thin and imperfect white cup which was slimy on the inside and flocculent-fibrous on the outside, differing decidedly from the volva of *A. vaginata,* which was compared with it carefully in the fresh state. The volva of the latter (buffy-gray form) was thicker, firmer, more perfect, smooth on the outside and not slimy within. Spores subspherical to elliptic, 7.5-9.3 x 9.4-11 μ. Drawing.

2212. Dr. Wheeler's lawn, June 23, 1916. Three plants; one a light steel gray on the margin to light mouse gray in center, the other two umber gray, one with numerous small, flat patches of the volva in the central region.

2312. Oak grove at The Rocks, June, 1916.

2415. Deciduous woods near path by brook, Battle's Park, July 22, 1916. Photo.

Asheville. Beardslee.

3. **Amanitopsis parcivolvata** Pk.

Amanita muscaria coccinia Beardslee.

PLATES 5 AND 62.

Cap 6-8.5 cm. wide, smooth, shining, viscid, no volva particles or a few soft, more or less pyramidal warts in center; strongly

striate on margin. Center deep scarlet, shading to orange on margin, the color of *A. Cæsaria* or the brighter forms of *A. muscaria.* Flesh very thin, yellowish.

Gills free, about cream color, not crowded, about 2.5 cm. deep in center, their edges dusted with fine yellow pulverulent particles.

Stem 10-14 cm. long and about 3 mm. thick, tapering upward, stuffed inside, ending below in a moderate bulb, or bulb absent; surface dusted with the same yellow pulverulence as the gills, which is most noticeable above.

Volva of white or yellowish rings and particles on bulb or base of stem, or very little signs of the volva on the stem, most of it becoming broken off in friable scales which remain sticking to the earth around, very much as in *Amanita Frostiana.*

Spores (of No. 801) white, short elliptic, 7.4-9.2 x 9.2-11 μ.

Common in lawns, groves, and occasional in cultivated places in June, less common in fall. In wet weather the colors of the cap tend to fade considerably as in *A. muscaria* and many other species.

Edibility not known.

801. In Dr. Pratt's lawn, east side in front, September 21, 1913. Photo. Spores 6.2-7.4 x 9.7-10 μ.

1197. In woods south of cemetery, not far from the path to Meeting of the Waters, that runs by branch, July 23, 1914.

2097. Dr. Lawson's lawn, June 14, 1916.

2103. Cultivated soil, Prof. Holmes' yard, June 14, 1916.

2105. Campus near chemistry building, June 14, 1916.

Asheville, common. Beardslee.
Ridge Crest, August 7, 1913 (No. 957). Coker.
Flat Rock. Memminger.

4. **Amanitopsis agglutinata** (B. & C.) Sacc.

A. volvata (Pk.) Sacc. *Agaricus soleatus* Howe.

PLATES 6 AND 62.

Cap 2.5-8 cm. broad, expanded and slightly gibbous at maturity, the surface nearly white or quite reddish from the reddish-brown squamules or scales which are more or less abundantly present, especially in the center, the scales decreasing to fine floccose fibers

toward the margin: sometimes, particularly in rainy weather, the scales and fibers more or less disappear. Between the scales the color of the cap is white; marginal third of the cap distinctly striate, sometimes pectinate. Flesh very thin toward the margin, about 4-5 mm. thick near the stem, soft, white, or light creamy pink and a deeper pink when bruised; taste mild.

Gills not crowded, distant from the stem when mature, not forked, a few short ones, white or faintly rosy when fresh, on drying or when bruised becoming a delicate and pretty light brown or pinkish-brown color; pointed at stem, broader and rounded at margin, the short ones truncate at the inner end, about 5-6 mm. deep.

Stem 6-14 cm. long, tapering upward, 5-10 mm. thick at top, 10-18 mm. thick at base; surface covered with small brownish-red or white, flocculent scales and particles (color of cap). A distinct central cylinder is present and is stuffed with soft cotton.

Volva a large ample sac, persistent and firm, usually not collapsing against the stem, but fused with it in the lower half, the free limb about 3-5 cm. long; surface white, turning brownish, covered with a white tomentum which holds firmly to the sand in which it grows. It dehisces apically and usually leaves no trace on the cap, but in No. 71 there was a large white patch left in center of cap.

Spores elliptic, varying considerably, pure white, 5-6 x 7.4-11 μ.

Rather common in sandy soil near streams and occasionally in drier sandy woods.

The regular and fibrous-looking patches which are inherent with its surface make the plant approach the appearance of a Lepiota in texture. This is our only species in the Amanita group that has a fibrous or flocculent covering on the cap under and distinct from the volva. The latter is a firm, dense, white membrane with a smooth inner surface which usually makes a clean break across the top as in Volvaria and in some species of Amanita and Amanitopsis.

In respect to the flocculence on the cap this plant resembles *Volvaria bombycina* and *V. parvula* and the general appearance of the plant and volva is more like a Volvaria than an Amanitopsis.

It seems possible that the species is really near Volvaria and not Amanitopsis, the white spores misleading one.

This species has been considered harmful, but (as *A. volvata*) McIlvaine speaks of it as delicate and tender, without pronounced flavor, and equal to *A. vaginata*. Ford and Clark (Mycologia 6: 167. 1914) place it with the very dangerous species.

71. In Battle's Park, growing in path, October 2, 1911.

515. Woods on other side of small branch south of campus, October 4, 1912. Two photos.

1109. By path along branch above Meeting of the Waters, July 9, 1914. Spores elliptic, with lateral mucro at one end, granular, sometimes with oil drops, 3.7-5.5 x 7.4-11 μ.

1194. Above path by branch north of Meeting of the Waters, July 13, 1914.

1208. On south bank of Bowlin's Creek in sand, along Fern Walk, above Emerson's Pond, July 25, 1914. Two photos. This was a fine lot of plants varying much in size, typical of one form, which is nearly always reddish salmon in color. The spores were white, smooth, elliptic, 5.1-6.8 x 8.5-10.2 μ.

1217. In cane brake on New Hope Creek, below Durham bridge, July 27, 1914.

1554. In dry open mixed woods, south of athletic field, June 19, 1915. Photo. Spores white, smooth, elliptic, 5.4-7.2 x 9-13.5 μ. Color of cap when young white on margin, brownish in center, at maturity becoming brown all over (a buffy tan, nearly warm buff of Ridgway). Flesh soft, white when cleanly cut, but turning pinkish at the slightest bruise, tasteless.

1576. In New Hope flood plain about one mile below Durham bridge, in almost bare soil among large trees, June 26, 1915. Margin of gills flocculent, the inner ends of the short ones squarely truncate, as in *Amanita muscaria*. Spores white, elliptic, smooth, 4.4-5.5 x 7.5-11 μ.

1587. By path along Battle's branch, July 6, 1915.

1601. By path along branch north of Meeting of the Waters, July 11, 1915. Photo with Nos. 1602 and 1603.

1602. In low shaded place near branch, 300 yds. west of Meeting of the Waters, July 13, 1915. Photo with Nos. 1601 and 1603.

1603. Growing in shaded place near Battle's branch, July 12, 1915. Photo with Nos. 1601 and 1602.

1629. Damp sandy soil by Battle's branch, July 22, 1915. Photo. Spores white, elliptic, smooth, 5.4 x 9 μ.

1861. Sandy soil, oak woods, Battle's Park and Rocky Ridge Farm, September 20 and 22, 1914. Spores elliptic, smooth, one oil drop, 5-6.3 x 9-12.6 μ.

2330. Damp rather sandy soil along Meeting of the Waters branches, June 30, 1916.

Asheville, common. Beardslee.
Flat Rock. Memminger.
Low district, pine woods. Curtis.

5. **Amanitopsis farinosa** (Schw.) Atk.

PLATES 7 AND 63.

A rather rare plant growing solitary in cool woods or open groves from June to fall. Cap about 2.5-5 cm. broad, ash-gray or mouse-gray to pinkish-straw color from the more or less extensive remains of the friable, mealy volva that covers it; margin striate with lighter lines. Flesh white, thin, 1-2 mm. thick at center, tasteless and odorless.

Gills white or nearly so, free, slightly crowded, 2-4 mm. wide.

Stem white or lighter than cap, sparingly or plentifully covered with white mealy particles, slightly enlarged at the base, but not bulbous, and not rooting, but abruptly rounded (nearly truncate) below as a rule, the very base ash or straw color from the mealy particles of the volva, or in some cases absolutely devoid of any sign of volva particles when mature; flesh solid, but soft inside.

Spores white, smooth, globose, a large mucro, variable in size, 4.4-7.6 μ.

Edibility not known.

Colored illustration: Mycologia 4: Plate 56. 1912.

69. Chapel Hill, October 23, 1911.
2069. In grove in front of Gimghoul Lodge, June 10, 1916. Sphores spherical, 5.5-7.4 μ.
2088. Grove in front of Gimghoul Lodge, June 13, 1916. Photo.
2136. Battle's Grove, June 15, 1915. Spores spherical, 4.4-6.3 μ.

Blowing Rock. Atkinson.
Asheville, common. Beardslee.
Montreat, rocky woods, July 6, 1915. Coker. Photo. Spores spherical, a large mucro, 5.5-7.6 μ.
Flat Rock. Memminger.
Middle district, woods (Schw.). Curtis.

6. **Amanitopsis pubescens** (Schw.)

PLATES 8, 9 AND 63.

A neat, sharply marked and very attractive plant growing in dry sandy soil in open groves. Cap from 2.3-6.4 cm. broad, depressed in center, the margin rounded and moderately striate; surface very light brown, near Ridgway's maize yellow, but lighter; adorned

with small, flattish, soft warts of the same color which are firmly adherent. Flesh nearly white, not changing when bruised, 3-4 mm. thick at stem, quickly thinning to a membrane on marginal third; no taste or odor.

Gills rather crowded, color of cap, of peculiar form, shaped like a tear drop, sharply pointed toward the stem, which they just touch, wide and rounded at the margin where they hang some distance below the cap. Their edges are covered with the fine flocculence often seen in other species of Amanitopsis.

Stem short and small for the size of the plant, from 1-2.5 cm. long above ground, 4.5-8 mm. thick in center and usually tapering downward to a short abrupt bulb which is usually more than half sunken in the ground; surface very pale ash gray (nearly white), pulverulent all over above the bulb, but not viscid as in *Amanita muscaria*. Flesh solid and firm with a central cylinder of white, rather firm stuffing. Bulb margined by the conspicuous but low, irregular rim of the volva, which is firm and covered on the outside with fibrous flocculence. Beneath the ground the bulb is covered with sand, which is held by the fine flocculence. A veil in all cases is entirely lacking.

Spores white, elliptic, 5-7.2 x 9-14.4 μ.

A remarkably distinct plant, quite different from any other species of Amanitopsis or Amanita. It is decidedly attractive and constant in its appearance and is rather firm, not quickly decaying. Its affinities are problematical, but it seems nearest *Amanita muscaria*. From *A. pusilla* Pk. (a doubtful species) it is easily separated by the broad gills, flocculent cap and much larger spores.

Edibility not known.

That this is Schweinitz's species I have no doubt. It has not been seen since he collected it at Salem, ninety-five years ago.

739. Very sandy, poor soil in path below athletic field to Meeting of the Waters, September 12, 1913. Photo. Spores white, elliptic, 5.5-6.6 x 8.5-11 μ.

767. Sandy dry walk in grass in grove near northeast gate of arboretum September 14, 1913. Spores elliptic, smooth, 5.7-2 x 9-14.4 μ.

1714. Growing in sandy soil in woods road, across branch south of athletic field, September 9, 1915. Spores elliptic, smooth, one large oil drop, 5.1-7.2 x 9-10 μ.

1756. Sandy soil by sidewalk in front of Dr. Wagstaff's. Spores elliptic, smooth, one large oil drop, 5.5-7.2 x 9-10 μ.

7. **Amanitopsis pusilla** Pk.

This little plant is very imperfectly known. It has been found but once and the type collection is in a very fragmentary condition. I have not been able to see the type so far, and venture no opinion on the validity of the species. For convenience of students I give below the original description by Peck (Rep. N. Y. St. Mus. **50**: 96. 1897):

"Pileus thin, broadly convex or nearly plane, subglabrous, slightly umbonate, even on the margin, pale brown; lamellæ narrow, thin, close, free, becoming brownish; stem short, hollow, bulbous, the bulb margined by the remains of the membranous volva; spores broadly elliptical, .0002 to .00024 in. long, .00016 broad [5-6 x 4 μ]. Pileus about 1 in. broad; stem 8-12 lines long, 1-2 lines thick. Grassy ground. Gouverneur, St. Lawrence County [New York]. September."

AMANITA

Usually solitary. Cap fleshy; surface glabrous or with warts, flat patches or mealy patches from the volva. Gills free or just touching the stem. Stem central, fleshy. Veil present,* forming an annulus or falling off in friable pieces, or torn into fragments which stick to the gills or margin. Volva present, forming a distinct sheathing cup or ridges and warts at the base of the stem, or fragile and friable and almost or entirely disappearing. Spores white usually, sometimes olive or cream color.

IMPORTANT AMERICAN LITERATURE.

NOTICE

For *Amanita nitida* Fr. see Addendum, page 87.

bulb, odor of chlorine.................................*A. virosa* (23)
1. Volva not as above, or if nearly so, no odor of chlorine.............. 8
2. Volva fused with the stem only at the very base; cap margin distinctly striate; stem with a distinct central cylinder that is lightly stuffed or hollow.. 3
2. Volva fused with the stem for 1 cm. or more, cap not striate or faintly so 6
3. Cap red or orange.....................................*A. Cæsaria* (1)
3. Cap not red or orange.. 4
4. Veil smoky, base bulbous, spores spherical..............*A. porphyria* (4)
4. Veil whitish or smoky, base not bulbous, spores elliptic.............. 5
5. Gills 7-10 mm. wide, cap white to pallid pinkish-tan......*A. recutita* (3)
5. Gills 4-6 mm. wide, cap more than 5 cm. broad, usually large ....*A. spreta* (2)
5. Gills 2-3 mm. wide, cap 2-3.5 cm. broad..................*A. spreta* var. *parva* (2a)

* The veil is frequently absent in *A. gemmata* and rarely so in abnormal plants of *A. muscaria*.

† Figures in parentheses refer to the plant's number.

1714. Growing in sandy soil in woods road, across branch south of athletic field, September 9, 1915. Spores elliptic, smooth, one large oil-drop, 5.1-7.2 x 9-10 μ.

1756. Sandy soil by sidewalk in front of Dr. Wagstaff's. Spores elliptic, smooth, one large oil drop, 5.5-7.2 x 9-10 μ.

7. **Amanitopsis pusilla** Pk.

This little plant is very imperfectly known. It has been found but once and the type collection is in a very fragmentary condition. I have not been able to see the type so far, and venture no opinion on the validity of the species. For convenience of students I give below the original description by Peck (Rep. N. Y. St. Mus. **50**: 96. [illegible]

AMANITA

Usually solitary. Cap fleshy; surface glabrous or with warts, flat patches or mealy patches from the volva. Gills free or just touching the stem. Stem central, fleshy. Veil present,* forming an annulus or falling off in friable pieces, or torn into fragments which stick to the gills or margin. Volva present, forming a distinct sheathing cup or ridges and warts at the base of the stem, or fragile and friable and almost or entirely disappearing. Spores white usually, sometimes olive or cream color.

IMPORTANT AMERICAN LITERATURE.

Murrill: N. Am. Flora **10**: 68. 1914.
Murrill: Mycologia **5**: 72. 1913.
Peck: N. Y. St. Mus. Rep. **23**: 96. 1872.
Peck: N. Y. St. Mus. Rep. **33**: 38. 1880.
Beardslee: Jour. E. Mitchell Sci. Soc. **24**: 115. 1908.
Beardslee: Mycologia **6**: 88. 1914.
Lloyd: A Compilation of the Volvæ of the U. S. Cincinnati, 1898.
Morgan: Jour. Mycology **3**: 25. 1887.

KEY TO THE SPECIES.†

1. Volva forming a distinct ample sheath with a free margin around the base of the stem, no odor of chlorine.......................... 2
1. Volva forming a distinct but narrow free ring at the top of an oval bulb, odor of chlorine..............................*A. virosa* (25)
1. Volva not as above, or if nearly so, no odor of chlorine.............. 8
2. Volva fused with the stem only at the very base; cap margin distinctly striate; stem with a distinct central cylinder that is lightly stuffed or hollow.. 3
2. Volva fused with the stem for 1 cm. or more, cap not striate or faintly so 6
3. Cap red or orange....................................*A. Cæsaria* (1)
3. Cap not red or orange.. 4
4. Veil smoky, base bulbous, spores spherical:..............*A. porphyria* (4)
4. Veil whitish or smoky, base not bulbous, spores elliptic.............. 5
5. Gills 7-10 mm. wide, cap white to pallid pinkish-tan......*A. recutita* (3)
5. Gills 4-6 mm. wide, cap more than 5 cm. broad, usually large ....*A. spreta* (2)
5. Gills 2-3 mm. wide, cap 2-3.5 cm. broad..................*A. spreta* var. *parva* (2a)

* The veil is frequently absent in *A. gemmata* and rarely so in abnormal plants of *A. muscaria*.

† Figures in parentheses refer to the plant's number.

6. Veil attached at very top of stem, flocculent beneath; spores elliptic.................................*A. magnivelaris* (8)
6. Veil not attached at very top of stem, not flocculent beneath......... 7
7. Gills becoming flesh color; spores elliptic............*A. hygroscopica* (7)
7. Gills not becoming flesh color; spores spherical or rarely elliptic.....................................*A. verna* (6)
8. Cap red, orange, salmon, or yellow, not brownish.................... 9
8. Cap brownish red or brownish yellow or pallid brown or ashy brown or umber brown... 12
8. Cap white, creamy, tan, pallid buff or drab.......................... 16
8. Cap greenish, or blackish brown, or smoky brown.................. 24
9. Cap strongly tuberculate-striate, egg yellow, veil white..*A. gemmata* (11)
9. Cap when fresh not striate or slightly so........................... 10
10. No smell of chlorine.. 11
10. Smell of chlorine, color light reddish or salmon..............................*A. chlorinosma* (form) (24*b*)
11. Cap orange yellow or salmon, volva patches not orange..*A. muscaria* (13)
11. Cap orange yellow, volva patches orange...............*A. Frostiana* (20)
11. Cap and veil primrose yellow, volva lavender......*A. mappa* (var.) (10)
12. Plant with smell of chlorine.. 13
12. Plant without smell of chlorine.................................. 14
13. Cap covered with ashy-brown warts.................*A. Atkinsoniana* (26)
13. Cap without warts, center covered with a friable, umber meal ....*A. cinereconia* (27)
14. Warts yellow, cap yellow-brown or buffy-vinaceous.*A. flavorubescens* (19)
14. Warts brownish, cap variable, mostly brownish red, flesh changing to red..*A. rubescens* (17)
14. Warts none or gray or brownish gray; flesh not changing........... 15
15. Stem hollow or lightly stuffed; spores elliptic..............*A. spissa* (14)
15. Stem solid; spores spherical.............*A. mappa (A. lignophila)* (9)
16. A strong smell of chlorine... 17
16. No smell of chlorine.. 18
17. Cap, veil, and stem covered wholly or in part with friable meal.............................*A. chlorinosma* (24)
17. No friable meal; cap and bulb usually strongly warty.............................*A. strobiliformis* (23)
18. Veil absent or very ephemeral; stem strongly glutinous......................*A. muscaria* (depauperate form) (13*a*)
18. Veil simple, thin; stem not glutinous.............................. 19
18. Veil compound, attached to stem by strong fibers................... 23
19. Plants rather small, or of medium size, a distinct volval roll or truncated bulb at base of stem..................................... 20
19. Plants large or medium, base of stem not as above.................. 21
20. Cap distinctly tuberculate-striate; spores elliptic........*A. cothurnata* (12)
20. Cap not striate or lightly so; spores spherical..............*A. mappa* (*A. floccocephala*) (9)

21. Center of cap smoky tan or smoky straw................*A. excelsa* (16)
21. Cap white all over, warts, if present, brownish........................ 22
22. Gills narrow, flesh reddish when bruised..............*A. rubescens* var. *alba* (18)
22. Gills broad, flesh not reddish when bruised.................*A. spissa* var. *alba* (15)
23. Bulb abrupt, smooth, large.............................*A. abrupta* (22)
23. Bulb not abrupt, warty..................................*A. solitaria* (21)
24. Cap greenish, a smell of chlorine............*A. chlorinosma* (form) (24*a*)
24. Cap smoky-black or smoky-brown in center..........*A. phalloides* (5)

1. **Amanita Cæsaria** Scop.

A. pellucidula Banning and Pk.

PLATES 10, 11 AND 63.

A large and conspicuous plant that is common in deciduous and mixed woods in summer, and occasional in fall. Cap expanded at maturity, smooth, up to 30 cm. wide, oval when young, shining, occasionally with a flat patch of the volva in the center, margin strongly striate at all ages, color yellow at the edge, shading through orange to deep red or orange-red.

Gills not crowded, free from the stem, a light but distinct yellow.

Stem up to 14 cm. long, slightly tapering upward, not bulbous, distinctly hollow, with a light pith when young; surface yellow, smooth and shining.

Veil light yellow, membranous, compound, *i. e.*, attached over several centimeters of the stem, remaining as a skirt about 1 to 2 cm. from the top.

Volva very large, white, thick and leathery, persisting as a large sheathing cup, which stands free from the stem and is attached at its very base.

Spores elliptic, white, averaging about 6.6 x 11 μ.

Colored illustration: Atkinson, Mushrooms, Plate 19, Fig. 1.

Very small depauperate plants are occasionally found, and in these cases the colors are less bright, as noted by Atkinson (Mushrooms, etc., p. 70). In our collections 544 and 1202 the plants were of this character. In 544 the cap was yellowish chestnut-brown, gills light yellow, stem and veil white.

Amanita Cæsaria is edible and in Europe is highly esteemed. I have eaten it, but did not think it particularly good.

450*a*. Chapel Hill, September 28, 1912. Spores 5.1-6.3 x 7.4-8.2 μ. (Plant lost.)
461. Battle's Park, September 30, 1912. Photo.
488. Woods southeast of school house, October 3, 1912.
505. Woods east of school house, October 5, 1912. Photo.
527. Woods south of campus, October 8, 1912. Photo.
544. Woods near path in Battle's Park, near crossing beyond Lover's Leap, October 10, 1912. A depauperate form.
650. Woods east of school house, October 10, 1912.
701. Woods south of Dr. Battle's house, June 20, 1913.
815. Woods back of Dr. Pratt's and in woods across the road from Dr. Pratt's, September 16, 1913.
1115. By path above Meeting of the Waters, July 9, 1914.
1120. Battle's Park, behind Mrs. Gore's, July 10, 1914. Photo.
1202. Near Battle's branch, July 24, 1914. Photo. This little plant was typical *A. Cæsaria* except for its very small size and dull yellow cap—not scarlet in center.
1614. In dry soil near pines near top of hill at "Fern Banks," July 16, 1915. Photo.

Blowing rock, Atkinson, also the depauperate form.
Asheville, very common. Beardslee.
Balsam, Jackson County (No. 1642). Sent us by Miss Totten.
Flat Rock. Memminger.
Common in oak forests. Curtis.

2. **Amanita spreta** Pk.

A. cinerea Bres.

PLATES 12 AND 63.

Cap up to 14 cm. broad, almost plane at maturity, naked or with a few fragments of the volva, which, when present, are leathery pieces and not warts; surface viscid, and with a separable cuticle, smoky brownish gray (Saccardo's umber—Ridgway), or varying rarely to nearly white; margin moderately or rather strongly striate Flesh white, soft, tasteless and odorless.

Gills crowded, the long ones pointed at the inner end and just reaching the stem, rounded and deepest near the outer end where they are 5-6 mm. wide, white, changing to sordid, many short ones with rather truncated inner ends.

Veil flocculent-fibrous below (not mealy granular), smooth above, delicate and rather fragile, often torn and perforated, usually separating entire and hanging from about 1 to 1.5 cm. from the top; collapsing completely against the stem in age and fading to a thin coating which, in Chapel Hill plants, is typically a light smoky color, but varies in this respect, at times being decidedly sooty, at others merely brownish with a faint smoky tint. There is no reference to a smoky tint in descriptions of the more northern form.

Stem large, up to 13 cm. long, tapering upward, about 10 to 14 mm. thick at top, nearly white or cinereous gray, especially below the veil, where it is flocculent-fibrous from the threads of the veil that connect with it when expanding. There is a large and quite distinct central cavity in the stem which is generally very loosely stuffed with a delicate cotton, which may be more or less dried up, and which collapses on exposure. There is no bulb. After examining many specimens I find that the stem is usually smoky gray when old, from the surface membrane of that color, which usually becomes broken up into scales and squamulose areas, especially above the veil. The veil usually partakes of this smoky change and it may be darker or lighter than the surface of the stem.

Volva rather thick and leathery, as in *A. virosa,* but becoming thinner in age, attached at the very base or very near the base of the stem, breaking irregularly into lacerations or large flaps which may be as long as 3 cm., or may be shorter and more broken with parts remaining on cap as thick, flat patches.

Spores white, elliptic, averaging about 7.4×11 μ, but varying greatly in size in different plants and at times in the same plant. Difference in habitat does not seem to be associated with any difference in the spores.

This species differs from *A. verna* and from *A. phalloides* in its hollow stem, color of cap, striate margin, more delicate veil, which is flocculent all over below and which usually changes to a smoky color (veil of *A. verna* and *A. phalloides* is smooth below, particularly on the marginal half), in the absence of a bulb, in attachment of gills by a tooth, in thicker volva which is usually less amply pre-

served, and in the elliptical spores. The color is much less variable than in *A. phalloides*, and there is a difference in tint, *A. spreta* being Saccardo's umber, while *A. phalloides* is more of a smoky color.

On September 14, 1913, I found in Battle's Park eleven plants of *A. spreta* within about 14 feet of each other. All of the caps had been broken and eaten by some animal, probably a land tortoise, as there was no sign of pieces being carried away and nibbled by squirrels. I also find that both *A. spreta* and *A. phalloides* are to some extent attacked by grubs. *A. verna*, on the other hand, seems to be always free from them.

This is one of our commonest species in Chapel Hill and it is less exacting in its habitat than any of our other Amanitas. It is often cespitose in clumps or strongly gregarious and is found in pine woods, oak woods, bushes, lawns, and bare clay, in damp, low, densely shaded places, and in quite dry, sandy open places. It is probably most common near the bushy borders of fields.

Ford has found both a hemolysin and a toxin in *A. spreta*, though in small amounts, and he classes it among the deadly species (Jour. Phar. and Exp. Ther. 1 : 281. 1909). However, in later experiments Ford states that he found that the heated extract while poisonous to guinea pigs, was harmless to rabbits (Jour. Phar. and Exp. Ther. 1 : 292. 1910). There do not seem to be any recorded tests of its effects on humans, although it is usually regarded as probably poisonous. From Mrs. I. M. Jervey, of Arden, however, I learn that she has established the reputation of this species as one of the best for making soup. From notes and drawings she has sent me there can be no doubt that this is the species she and her friends eat. She says that it should be run through a meat chopper, stewed slowly with water in a double boiler for three hours, then pepper, salt and milk added. She says (in a letter of January 30, 1917): "No one has ever been made the least sick by eating this soup, and it is delicious." However, the warning cannot be too often repeated that no one should eat this or any of the Amanitas on faith from descriptions alone, and even when convinced that the species is known and harmless, it should be accepted as edible only

after careful experiments with small quantities. This is especially true of species like *A. spreta*, which have been found to contain more or less poison.

A. porphyria is said to have a sooty black ring, and in this respect our form of *A. spreta* approaches it with its smoky veil, but the former species has spherical spores, is bulbous, and is not striate on the margin. It has not yet been found in North Carolina.

424. In low leafy place close to Battle's branch, below blue bench, September 21, 1912. Photo.
428. Near branch back of Dr. Wilson's, September 22, 1912.
439. Woods southeast of athletic field, September 26, 1912. Spores averaging about 7.3 x 11 μ, but varying greatly in the same plant, some 6.6 x 10 μ, a few very large, 10-15.2 μ.
487. Scattered in woods, Battle's Park, October 5, 1912. Photo. Spores 5.9-6.7 x 10-12.2 μ.
512. Woods east of school house, October 5, 1912.
520. Woods east of school house, south of campus, October 7, 1912.
734. Woods at top of Lone Pine Hill, September 10, 1913. Photo. Spores 7-8.2 x 10-11.8 μ.
1664. Under hornbeam near spring in arboretum, July 28, 1915. Photo. A large group of fine plants. Spores white, short elliptic, smooth, 5.1-6 x 7.5-10 μ. These spores are somewhat smaller than in other collections, but the plants were otherwise identical.
2108. Roadside at "The Rocks," and in the old Mangum yard, June 14, 1916.

Blowing Rock. Atkinson.
Asheville, very common. Beardslee.
Flat Rock. Memminger.

There is little doubt that Curtis included this in *A. recutita*, which he says is common in woods.

2a. **Amanita spreta** var. **parva** Beardslee.

Venenarius virginianus Murrill.

PLATE 63.

This is an extreme little form of *A. spreta* and is a small plant with a very pale cap, and veil not smoky. Cap 3.5 cm. broad, pale buff in center, fading to nearly white on margin which is strongly striate. Gills attached, about 3 mm. deep, white. Stem 13 cm. long, 6 mm. thick, nearly white, finely fibrous below the veil,

minutely granular above; a distinct central cylinder that is lightly stuffed. Veil a small collapsed ring 2 cm. from the cap, white. Volva long, narrow, attached to the very base of the stem, which is not at all bulbous. Spores elliptic, 6.7-8.2 x 10-12.6 μ.

Murrill's *Venenarius virginianus,* found in the Virginia mountains, is the same as this. In the type plants of the latter the stem is quite hollow and the spores identical with ours. I find them to be 7.5-10.5 x 11-13 μ. The cap is described as "fuliginous." (N. Am. Flora 10: 71. 1914.) Beardslee's description is as follows (Jour. E. Mitchell Sci. Soc. 24: 118. 1908):

"Pileus 0.5-1 inch broad, thin and membranous, soon plane or depressed, deeply sulcate-striate on the margin. Stipe slender, white, with a distant, almost median annulus. Spores as in the type. It may be readily known by its small size."

1624. In moldy earth in oak grove west of "The Rocks," July 21, 1915.

Asheville, on dry hillsides. Beardslee.

3. **Amanita recutita** Fr.

PLATES 13 AND 63.

The following is the description of the Chapel Hill plant. For the coastal plane form with lighter cap and less fragile volva see below under the Hartsville collection.

Cap 4-8.5 cm., usually about 6 cm., broad, flat or depressed in center, quite viscid when wet, naked or with a few soft, white patches of the volva in center, a thin separable cuticle, the margin distinctly striate for about 1 cm.; color a light pallid tan with a shade of smoky-pink, fading to nearly white on the margin. Flesh very thin toward margin, 5 mm. thick at center, white, soft, tasteless and odorless when fresh.

Gills distinctly but lightly attached, pure white, moderately close, somewhat veined at the cap, quite broad, ventricose, 1 cm. wide in middle, rounded at the outer edge and hanging far below the cap margin, the short ones truncate at the inner end. Where the stem is colored like the cap the margin of the gills is apt to partake of this color.

Stem nearly equal, distinctly marked above by lines from the

gills, smooth or lightly fibrous below, white or color of the cap above. In the center is a distinct central cylinder with a very light stuffing which collapses when exposed.

Veil thin, lightly flocculent below, collapsing against the stem to form a ring about 2.5-3 cm. from the cap, which makes it nearly median at times, nearly white or colored like the cap.

Volva very soft, thick, fragile, nearly white, attached near the base, but closely sheathing the stem and breaking circumcissilly, leaving a flat top with a marginal rim which is more or less broken or irregular. So fragile is the volva that separated fragments remain sticking to the soil in all cases, so that a complete cup is not preserved.

The stem is not at all bulbous in itself, but the thick, soft volva makes it seem so, especially when young; when collected or when old the substance of the volva shrinks much and is less thick. As the stem is well inserted in the ground, the volva rim is usually at or below the surface.

Spores (of No. 1684) elliptic, smooth, 5.2-7.4 x 8.5-11.5 μ.

Edibility not known (but see under *A. spreta*).

It does not seem possible to refer this to anything but *A. recutita*, but I confess to some doubt in regard to it. Fries' description agrees rather well with our plants, except that he speaks of the surface as dry and the margin as rather smooth. Curtis lists *A. recutita* as common in woods, and there is in his herbarium a poorly preserved plant with this label from Society Hill, South Carolina (near Hartsville), the spores of which agree with our plants. I find them to be, in his plant, 6.6-7.4 x 11-12 μ. He doubtless also included under *A. recutita* the form we now refer to *A. spreta*.

In his list of Blowing Rock fungi (Jour. E. Mitchell Sci. Soc. 9: 98. 1892) Atkinson lists *A. recutita* (determined by Morgan). I have seen the plant on which this determination was based, but could get no spores from it, and could not be sure of the pressed specimen.

The species differs from *A. spreta*, which is nearest, in smaller size, much wider gills, distinctly more fragile volva, and lighter color of the cap and veil. The veil may be nearly white or color of

cap, but is not smoky as in *A. spreta* (at Chapel Hill) and *A. porphyria.* A typical fresh plant of *A. spreta,* compared with the above when the description was written, clearly showed these distinctions. Its gills were only 6 mm. wide at best; and the volva tough and persistent; the veil smoky. For further notes and comparisons see under *A. spreta.*

1684. In scattered groups, poor clay soil by path from arboretum to Dr. Battle's, open places, in bare soil and in grass, September 6, 1915. Photo.

Blowing Rock. Atkinson.

Common in woods [probably meaning *A. spreta*]. Curtis.

Hartsville, S. C., July 16, 1916. Sandy soil in a thick grove of second-growth long-leaf pines.

The plants were numerous and resembled closely the Chapel Hill form described above except that the cap was lighter and the volva was not so fragile. The description follows:

Cap 2.5-7.5 cm. broad, convex then nearly plane, the center often depressed, margin strongly striate for a variable distance; color nearly white, the center straw color, moderately viscid, smooth, with or without a few thin, flat patches of the white volva. Flesh pure white, soft, not very fragile, about 5 mm. thick near stem. Odor in old age peculiar, much like that of rotting cow peas.

Gills not crowded, many short and these truncate at the inner end, distinctly but narrowly attached and usually decurrent by a line, about 8.5 mm. wide in large plants, white when young, a light straw color when mature.

Stem 7-14 cm. long, 7-12 mm. thick in center, tapering upward, but suddenly enlarged at the cap; surface white, nearly smooth or slightly slivered below the veil, a distinct central cylinder which is stuffed with delicate cotton, not bulbous, but deeply seated in an ample, membranous, white volva which is attached for only about 0.5-1 cm. at base, and usually stands free and open.

Veil delicate, thin, not friable, membranous, collapsing as a delicate white ring about 1.3-2.5 cm. from the cap.

Spores white, elliptic, smooth, 5.5-7.7 x 10.3-14.8 μ.

It is of interest to note that Fries reports *A. recutita* as occurring in pine woods.

4. **Amanita porphyria** Fr.

PLATE 63.

This species has not yet been found in the South, and I append the description given by Murrill in N. Am. Flora **10**: 70. 1914.

"Pileus campanulate to expanded, solitary, 4-5 cm. broad; sur-

face moist, subglabrous, subfuscous, varying to livid purple or brown, smooth on the margin; lamellæ adnexed, white; spores glabrous, smooth, hyaline, 8-10 μ; stipe stuffed or hollow, bulbous at the base, glabrous, whitish or subconcolorous, 6-8 cm. long; annulus membranous, persistent, superior, becoming sooty black; volva free, whitish or subfuscous, adnate to the base of the large, rounded bulb, conspicuous, lobed, thick and fleshy, persistent. In pine woods."

I have examined spores of a plant from Sweden collected by Romell (Herb. N. Y. Bot. Garden), and find them globose with a small apiculus, 6.6-8.2 μ. Beardslee gives the spores as 10-12 μ in diameter. The sooty veil is often spoken of as characteristic of *A. porphyria*, but it will be noted that in Chapel Hill the veil of *A. spreta* is also sooty.

Ford has found *A. porphyria* from Massachusetts to contain a small amount of a heat resistant poison which he thinks similar to that in *A. phalloides* (Jour. Phar and Exp. Ther. 1: 283. 1909).

5. **Amanita phalloides** Fr.

PLATES 14 AND 63.

This is a common species in Europe and the northern United States, but in this latitude it is rare and tends to be dwarfed in size and modified in structure. *Amanita verna,* regarded by many as only a form of this species, is with us entirely distinct and very abundant. Though the typical form of *A. phalloides* in Europe and the Northern States has usually a conspicuous volval cup at base, there is also in the North a form like ours where the cup is absent, the flattish bulb having only a low ridge or simply a line representing the attachment of the universal veil (Peck, N. Y. St. Mus. Rep. 33: 43. 1880). Our larger and more typical form is very rare and is found in rich mold in mixed woods. It may be described as follows:

Cap expanded, gibbous, the margin sometimes elevated, 6-9.3 cm. wide, scarcely viscid, smooth, without conspicuous inherent fibers, with or without a few flat, white, mealy volva patches; margin not striate or with a few faint lines when fully mature; color variable,

usually smoky black or smoky brown in center, sometimes Brussels brown (Ridgway), varying to much lighter brownish straw (nearly pallid white), the margin smoky-tan in the darker form to straw color or pallid white in the lighter. The plants are never the clear white of *A. verna*. We also have a small form (No. 2314) in which the cap is buffy yellow with a tint of green. When bruised the surface of both cap and stem is very apt to turn a decided brownish red in all forms, exactly as in *A. rubescens*, and the bulb and grub channels of the stem are nearly always reddish.

Gills pure white, free, but connected by a line with the stem, rather crowded, narrow, only 6 mm. wide in middle.

Veil thin, white, not very fragile, breaking from the cap margin and hanging like a skirt about 2-3 cm. from the top of the stem. It is just like the veil of *A. verna* in appearance and behavior.

Stem up to 16 cm. long and 1.3 cm. thick in center, usually tapering slightly upward, sometimes nearly equal, ending below in a distinct, usually flattish bulb that is buried in the ground; surface smooth, shining, white. Flesh firm on the surface, softer inside with fibrous material, but not hollow in our plants, and without a clear cut central cylinder as in *A. spreta;* bulb usually flattish on top and with a marginal line, or with slight, thick, marginal elevations, a volval cup being absent. Brick-colored stains are not unusual on stem or bulb where they have been rubbed.

Spores (in No. 796) white, globose, smooth, 5.9-7.7 x 6.6-8 μ in diameter; in No. 174 they are 8-9 μ.

Deadly poisonous, containing Amanita-hæmolysin and Amanita-toxin, and with no known antidote. See Ford and Brush (Jour. Phar. and Exp. Ther. **6**: 195. 1914; and other papers there referred to).

Colored illustrations: Murrill, Mycologia **8**, No. 5, Plate 190, Fig. 5. 1916. Murrill, Mycologia **5**, Plate 87, Fig. 1. 1913. Gibson, "Our Edible Toadstools and Mushrooms," Frontispiece.

It is very important to remember that the change of color to reddish is like the change in *A. rubescens*, an edible species with a very similar bulb, and to let that species alone except in the plainest cases.

174. Mixed woods near Dr. Battle's, September 14, 1910.

301. Battle's Park, September 27, 1911. One plant. Bulb abrupt, volva represented only by a thick margin to the bulb. Cap not striate, smoky gray or brownish. Spores globose, varying considerably in size, 8.3-10 μ in diameter.

542. Woods near branch back of Dr. McKie's, October 10, 1912. Photo.
Cap deep smoky brown, almost black in center, margin smooth, bulb with slight marginal elevations. Spores globose, about 8 μ in diameter.

796. Near Battle's Brook, September 19, 1913. Spores 5.9-7.7 x 6.6-8 μ.

812. Near first bridge on Battle's Brook, September 21, 1913.

1450. Thick woods by branch on path from graded school to campus, October 26, 1914.

2254. Mixed woods north of cemetery, June 26, 1916.
Cap up to 9.5 cm. wide, very pale brownish tan with stains of brick where bruised. Bulb abrupt, large, cracked, scarcely margined, stained with brick as was also the solid stem. Spores spherical, 7.4-8.5 μ.

2294. Under alders by Battle's branch at first bridge, June 28, 1916. Spores spherical, 7.4-10.7 μ. Plants appear in this spot every year.

Asheville, rare. Beardslee.

Blowing Rock. Atkinson.

Flat Rock. Memminger.

Common in woods. Curtis.

5*a*. **Amanita phalloides.** Depauperate Form.

There is with us a small, pallid, slender form, that may be described as follows: Cap from 3.3-5.7 cm. wide, strongly gibbous, quite smooth and rarely with any volva patches, color pallid tan with sordid brown or reddish stains. Stem 5.6-11 cm. long, 3-4 mm. thick, nearly equal, faintly fibrous, color and stains of cap, a small bulb entirely hidden in the earth, with an obsolescent ridge at top or with a few short thick projections on the margin; flesh solid. Gills white, crowded, narrow, just reaching the stem, 2.5 mm. wide in center. Spores white, spherical, smooth, 7-10 μ in diameter in No. 1788; 7.2-9 μ in No. 1816. This form grades into such forms as No. 2254 above.

1788. Small pallid slender form. Growing in mixed woods across road 1/8 mile southwest of graded school, September 15, 1915. Photo.

1816. Two plants. In damp woods by Howell's branch, September 17, 1915. Small pallid form.

6. **Amanita verna** Bull.

Plates 15 and 64.

A common plant of good size, growing solitary or in groups of two or three in deciduous woods in late summer and fall. Cap pure white or the center cream colored, expanded, entirely smooth or with one or more flat patches of the volva, shining, viscid when damp, the margin quite even or very slightly striate. In the fresh young pileus the margin is at times adorned with a narrow, delicate, lace-edged rim from which the veil was ripped.

Gills rather crowded, many short, just reaching the stem, white and remaining so in age.

Veil thin but persistent, not tomentose or flocculent below, remaining attached to the stem as an ample skirt about 1 to 1.5 cm. from the cap. Later it collapses against the stem and often in damp weather absorbs moisture and becomes reduced to a yellowish slime.

Stem long and rather slender, white, smooth or with scales and lacerations, never friable and flocculent, more slender than in *A. virosa*, solid or hollow toward the top; no central cylinder (but see note under 913), ending below in a buried bulb which is generally obvious, but varies much in size.

Volva ample, white, dehiscing apically and remaining as a more or less perfect cup, which is thin and papery usually and collapses against the stem. Sometimes it is more leathery and approaching the texture of the volva of *A. magnivelaris*.

When withering the plant often becomes water-soaked, beginning at the margin of the pileus.

Spores pure white, smooth and spherical or short elliptic, varying a good deal in size in the same plant. They vary from 7.5-11 μ in diameter and average about 8-9 μ.

Deadly poisonous.

Peck gives the spore shape as the most marked distinction between *A. verna* and *A. magnivelaris,* and so does Atkinson for *A. elliptosperma*. In *A. verna* they should be spherical or nearly so, and in the two last elliptic. This distinction has usually held in my experience, but in Chapel Hill one meets with many plants of *A.*

verna in which the spores are elliptic. In plant No. 420 the spores were about 7.4 x 10 μ, although the plant was as pretty and perfect a specimen of *A. verna* as any one could wish, with the veil about 1.5 cm. from the cap, a glabrous stem and a thin collapsed volva. In a good plant of *A. verna* brought in on October 14th the spores were about 7.4-8 x 9 μ on an average, but some were perfectly spherical. A plant tested on October 15th had spores spherical, about 8 μ in diameter; in another plant they were also spherical and 6.5-8.3 μ in diameter.

For differences between *A. verna* and *A. magnivelaris* see under the latter species.

154, 155, 156, 157, 158, 163, 310, 329 were collected in every direction during October, 1911.

420. Low woods south of Dr. Wheeler's, September 20, 1912. Spores elliptic, 6.6-8.5 x 9.7-11 μ.

433. Battle's Park, September 26, 1912. Spores nearly spherical, 7.4 x 7.9 μ.

437. Woods southeast of athletic field, September 24, 1912.

454. Near Howell's branch, September 28, 1912.

470. Battle's Park, back of Dr. Pratt's, September 30, 1912. Spores spherical or somewhat elliptical, 7.4-8 x 7.4-9 μ.

572. Near Howell's branch, October 17, 1912. Veil deliquesces to a yellow ring. Spores spherical.

570. Woods south of campus, October 14, 1912. A depauperate specimen. This little plant was only 3.3 cm. broad and 4.2 cm. high. The veil in this case had deliquesced to a yellow ring as in the large specimen of 572. The spores were those of a normal plant, nearly spherical, 7.5-10 x 10-11.5 μ.

707. Woods south of Dr. Battle's house, June 20, 1913. A typical plant of *A. verna*, but the spores were elliptic, 6.3-7 x 7.8-11 μ.

749. Woods near Meeting of the Waters. Spores short elliptic, 5.8-7.5 x 6.6-8.2 μ. Veil in two specimens water soaked and yellow.

783. In woods south of athletic field, September 17, 1913. Spores of this were spherical, 6.5-11 μ in diameter.

913. This fine plant, typical in every other respect, had the central part of the stem split away all around from the marginal part; that is, there was a central core about 4 mm. in diameter standing free in a distinct cylinder.

1257. On bank of Battle's branch, just above the first bridge, September 24, 1914. Photo.

1261. In grass in Dr. Wagstaff's yard, September 24, 1914. Photo.

1273. In damp loam in woods above Meeting of the Waters, September 28, 1914. Spores spherical, 6-8.5 μ.

1480. Woods west of "The Rocks," November 19, 1914.

2075. Shaded lawn at the old Mangum place, June 12, 1916. A very small form. Spores elliptic, smooth, 6.6-7.4 x 8.5-11.8 μ.

Flat Rock. Memminger.
Blowing Rock. Atkinson.
Asheville, common. Beardslee.
Common in woods. Curtis.

6a. **Amanita verna** Bull. Form with two-spored basidia.

A. bisporigera Atk.

PLATES 16 AND 64.

We have in Chapel Hill, as at Ithaca and other places, a smaller and earlier form of *A. verna* in which the basidia bear only two spores, and not rarely, in our plants, only one. As it is like *A. verna* in other respects and seems to vary into it, I shall treat it as a form of that species. I have found basidia with only two spores mixed with the four-spored ones in the typical, large plants of *A. verna*. Perhaps there is simply a tendency to the two-spored state in *A. verna*, which becomes dominant in the smaller plants. This smaller form appears as early as June, extends through the summer into September. It may be described as follows:

Cap 2.5-7 cm. broad, shiny, slightly viscid, quite smooth or with patches of the membranous volva in center. Margin slightly striate, and when just out of the volva, beautifully fibrous for about 1 cm. Color pure white all over to pale tan with the center abruptly darker, about rufous. The cap is at times marked with short, sharp, elevated ridges which seem to push up under the cuticle. Flesh white, very thin, about 2 mm. thick at center, thinning very quickly to less than 1 mm.

Gills rather close, many short, just reaching the stem, about 6 mm. deep in center, rounded at both ends, white.

Veil white, very thin and membranous, not flocculose below or fragile, attached about 0.5 to 1 cm. from the cap and hanging collapsed against the stem.

Stem slender, tapering upward, 7.5-15 cm. long, 3.5-6 mm. thick in center, abruptly enlarged below into a short, soft bulb, which has no tapering point below, surface smoothish or somewhat fibrous, white; flesh solid, no central cylinder.

Volva adnate to the bulb, with a conspicuous, free and usually split border which is very thin and papery, or moderately thick, and which extends about 0.5 to 1.5 cm. above the bulb.

Spores white, spherical, smooth, 7.2-11 μ in diameter; basidia two-spored.

This form was first described by Prof. Atkinson from Ithaca, N. Y. (Bot. Gaz. 41 : 348. 1906) and our No. 152 was determined by him as this species. Our notes on this number were incomplete, and as we had not again distinguished the plant in Chapel Hill for several years we had about given it up as identical with *A. verna* until the early summer of 1915 when two plants were found (No. 1567), which struck us immediately as different from *A. verna*, being more slender and with some color in the cap when old. Examination of the basidia showed them all to be two-spored. Since then a number have been found.

152. Top of Lone Pine Hill, Glenn Burnie Farm, in mixed woods, September 19, 1908.

1567. In low woods not far from Battle's branch, below last path to Piney Prospect, June 21, 1915. Photo. Spores spherical, 7.2-9 μ.

1586. By path along Battle's branch, near the first seat below first bridge, July 6, 1915. Photo. Spores subspherical, smooth, 8-10.8 μ. A single small plant, 3.5 cm. wide and 7 cm. high. Basidia examined and found to be all two-spored. Cap white except for cream-colored center.

1598. Low place near Battle's branch, July 12, 1915. Photo. One small plant 2.5 cm. wide and 7.5 cm. high. Cap pure white all over. Basidia all two-spored. Spores subspherical, 9-11 μ.

1645. In leaves under a beech tree near Battle's branch, July 26, 1915. Spores spherical, 8-11 μ, usually about 9 μ in diameter, only two to a basidium, rather often only one spore matures on a basidium, the other remaining rudimentary (see drawing).

2165. Woods near Meeting of the Waters, June 20, 1916.

2159. Grass under oaks, Prof. Howell's yard, June 20, 1916.

2271. Under oaks at "The Rocks" and at Gimghoul Lodge, and in Battle's Grove, July 27, 1916. Photo.

7. **Amanita hygroscopica** n. sp.

PLATES 17, 18 AND 64.

Cap 4.5-6 cm. broad, rounded or gibbous, smooth and wet-looking, viscid, the margin even or with delicate lines, nearly plane,

pallid white, the center shading to straw or pinkish-straw color. Flesh only 2 mm. thick near center, nearly white, odorless and tasteless, not changing when bruised.

Gills 4-4.5 mm. wide, moderately close, rounded at stem and just reaching it, white then discolored to fleshy-buff or flesh-color.

Veil white, thin, delicate, almost always torn and hanging as a collapsed and fragmented ring about 1.5-2 cm. from the cap.

Stem up to 8 cm. long, including the bulb, 5-6 mm. thick in center, tapering upward, nearly smooth, white or with a few stains of brown below, ending in a good-sized or large bulb to which is attached an adnate volva with a free limb about 5-10 mm. long which is collapsed on the stem; center of stem with a rather distinct central cylinder which is rather lightly stuffed, but not hollowed except by grubs.

Spores white, elliptic, smooth, 6.6-7.8 x 10-11.5 μ, most about 6.6 x 10.5 μ.

Edibility not known.

This is most like the small, two-spored form of *A. verna* in size and general appearance, but is really quite different. It is distinguished from this form and from the typical *A. verna* by its wet cap (a quality which remains obvious in the central region for hours after the plant is placed in the dry air); the gills turning distinctly flesh colored; the very softly stuffed central cylinder, which is usually quickly hollowed by grubs; the more fragile and torn veil; the very different, elliptic spores; and the greater brittleness and fragility of all parts.

From *A. elliptosperma*, which is nearest structurally, it differs in smaller size, distinct central cylinder, absence of flocculence on veil and stem, lower attachment of veil, and in the wet cap, and distinctly larger spores. See drawing.

From *A. spreta* it differs in color of cap and gills, in the bulbous stem with adnate volva, and in the smaller spores of different shape.

2261. Under oaks in manured soil around small hemlocks, lawn of "The Rocks," June 26, 1916. Photo. Type.

2275. Same place as above, June 28, 1916. Photo.

8. **Amanita magnivelaris** Pk.

A. elliptosperma Atk.

PLATES 19, 20, 21 AND 64.

A large and conspicuous species that is not rare in mixed and deciduous woods. Cap up to 10 cm. broad, often elliptic or one-sided, chalky white or light cream, shining, slightly viscid, and with no sign of warts except occasionally a trace of friable material toward the edge, or with a large flat piece of the volva; margin not striate. Flesh white, unchanging, almost tasteless and odorless.

Gills light flesh-colored, with many short and sometimes forked ones.

Stem pure white, 8-15 cm. long and 0.9-2.5 cm. thick in center, slightly tapering upward, scarcely bulbous below except for the enlargement due to the thick volva which is fused with its base. Below the free limb of the volva extends a more or less pointed root, usually 2 or 3 cm. in length. Surface typically flocculent on the upper half or nearly the whole length where the veil touched it in youth. Sometimes nearly glabrous, except above, often more or less torn below; flesh solid all through; no distinct central cylinder.

Veil very fragile but not friable, attached at very top of stalk and remaining attached to it as an ample skirt, or in many cases breaking away and sticking to the gills in fragments, or hanging to the edge of the cap. It is very delicate, thin, and *densely soft-flocculent* on the lower side (not with coarse, mealy, friable particles as in *A. chlorinosma*), but does not deliquesce to a slime in wet weather.

Volva thick, tough, leathery, persistent, usually splitting irregularly and remaining at the base of the stem as large flaps or slivers, rarely approaching a perfect cup. It is usually, but not always, much thicker and heavier than in *A. verna*. Some times one or rarely two or three large flat pieces may be torn off and remain sticking to the cap.

Spores elliptic, with a very small eccentric mucro, usually about 5.5-7.4 x 8-11 μ. Sometimes 13 μ long, and occasionally (as in No. 1806) much smaller.

Edibility not known.

This species has not been well understood in America and is not recognized by Murrill or Beardslee. It is, however, very distinct and seems to represent a connecting link between the phalloides and chlorinosma groups. I have placed it in the former group because of the large volva and absence of chlorine odor, but it is in reality probably more closely related to the latter, as shown by the flocculent, fragile and quite apical veil, the flocculent stem with rooting base and the shape of the spores. It is probably nearest *A. virosa*.

Amanita elliptosperma was described from our plants by Prof. Atkinson (Annales Mycologici 7: 366. 1909). I have examined the type of *A. magnivelaris*, and have no doubt that it is a good species and that it is almost certainly the same as *A. elliptosperma*. In the fresh state this species can be distinguished without difficulty from *A. verna* without any reference to the spores. In my observations of many plants of these two species, extending over six years, I have found no confusing intermediates. In *A. magnivelaris* the veil is quite fragile and not deliquescent, is attached at the very top of the stem and is *densely soft flocculent* below, the stem is also flocculent above or all over, is terminated below by a more pointed bulb, and is, typically, considerably stouter than in *A. verna*. The gills are light flesh color and the spores are elliptic. In *A. verna* the veil is attached about 1 cm. from the cap, is less fragile but apt to fade or deliquesce, and is not flocculent below, the stem is not flocculent, and the gills are pure white.

As described by Peck, *A. magnivelaris* would be considered doubtfully distinct from *A. verna*, but the radicating base, as noted and as shown clearly in his plants, is an important point, and the spores, which I have carefully examined, are *not* like those of *A. verna*, but are identical with those of *A. elliptosperma*. While the spores of *A. verna* are not rarely elliptic and may approach those of *A. magnivelaris* in shape, there are to be found others in the same plant much more nearly round than any in the latter species; moreover, they average rounder in any spore print of *A. verna* and the mucro is larger. Another difference is in the appearance of the spore contents after standing in the herbarium. Those

of *A. verna* are of a homogeneous oily appearance with eroded spots, while those of *A. magnivelaris* from New York and from Chapel Hill also as a rule are distinctly granular and not oily. It is true that Peck describes his plants as having a glabrous stem, but this does not seem to be of great importance, as the amount of flocculence is variable and is reduced by exposure or by handling.

It is probably this species to which Curtis refers without name in the Berkeley-Curtis MSS. as follows:

"2869. (Spec. nom cum desc. quadrat volva non a dist.) Cap plane or plano-concave, 3 in. wide, smooth and glabrous, with a few irregular patches of the volva near center, margin not striate. Lam. dirty white with a yellowish tinge, subdenticulate. Spores copious, white. Ring attached just under the gills. Stipe 4-5 in. long, solid, white, squamulose, dilated when joining the cap, bulbous at base. Volva loose at the margin, divided into 4-5 laciniæ. July-October. Earth."

160. Woods by road southeast of cemetery, October 24, 1910. Spores 5.9-6.6 x 9.7-10.8 μ.
161. Open woods east of Gimghoul Hall, September 17, 1908.
452. Woods near Dr. Battle's house, two photos. Here the volva was torn into heavy thick flaps, which would sometimes remain attached to the cap in part. Spores 6-6.7 x 7.8-10 μ, most about 4.8 x 8.5 μ.
553. Open woods in several places around Chapel Hill, October 9, 1912. Two photos. Plants of this collection had the entire stem minutely flocculent like the under surface of the veil.
782. Mixed woods back of athletic field, September 17, 1913. Spores 5.5-7.4 x 8.3-11.1 μ.
928. Battle's Park, October 16, 1913. Spores elliptic, 5.5-7.4 x 7.4-11 μ.

9. **Amanita mappa** Fr.

A. floccocephala Atk. *A. lignophila* Atk. (?)

As the form of *A. mappa* at Chapel Hill has certain distinct peculiarities, I give below a description of the Asheville plant by Beardslee as more typical:

"Pileus 2.5 in. broad, yellow or pallid, dry, with flat white or yellow scales from the fragments of the volva, even on the margin; gills white, slightly adnexed; stipe stuffed, then hollow, white, striate at the apex, with a globose marginate bulb. Spores globose, 8 μ.

"Found in pine woods, rather rare. This is identical with the plant which is found in Sweden. It is much like *A. phalloides* in some regards, but has no free volva. The basal portion of the volva is adnate to the bulb and is cut squarely across, forming a thick margin at the margin of the bulb."

The species is said to be poisonous. Ford and Sherrick (Jour. Phar. and Exp. Ther. 4: 327. 1913) say: "Heated extracts had no effect upon rabbbits, but produced a chronic intoxication in guinea pigs from which the animals died in about ten days. . . . The specimens we have examined are certainly free from muscarine and closely resemble *Amanita phalloides* in their properties." From later experiments Ford and Brush find that, "In all probability *Amanita mappa* contains both Amanita-hæmolysin and Amanita-toxin, but in much smaller quantities than *Amanita phalloides*" (Jour. Phar. and Exp. Ther. 6: 192. 1914).

I have examined the type plant of *A. floccocephala* Atk., and find it like *A. mappa* in the dried state. I could not find any spores. Atkinson's description of this form is as follows (Studies of Am. Fungi, p. 62):

"This species occurs in woods and groves at Ithaca during the autumn. The plants are medium sized, 6-8 cm. high, the cap 3-6 cm. broad, and the stems 4-6 mm. in thickness.

"The pileus is hemispherical to convex, and expanded, smooth, whitish, with a tinge of straw color, and covered with torn, thin, floccose patches of the upper half of the circumscissile volva.

"The gills are white and adnexed.

"The spores are globose, 7-10 μ.

"The stem is cylindrical or slightly tapering above, hollow or stuffed, floccose scaly and abruptly bulbous below. The annulus is superior; that is, near the upper end of the stem, membranaceous, thin, sometimes tearing, as in *A. virosa*. The volva is circumscissile, the margin of the bulb not being clear cut and prominent, because there is much refuse matter and soil interwoven with the lower portion of the volva. The bulb closely resembles those in Cooke's figure (Illustrations, 4) of *A. mappa*."

Amanita lignophila Atk. (Ann. Mycol. 7: 366. 1909) is probably also a form of *A. mappa.* It is described as follows:

"Plants 5 cm. high, pileus 2.5 cm. broad, stem 3 mm. stout; bulb abrupt, rotund, 12 mm. stout. Pileus dull grayish brown, smooth or with fine floccose remnants of the volva, viscid when moist. Gills sordid, very crowded, subventricose, adnexed and decurrent in striæ, edge finely fimbriate. Basidia 30-35 x 8-10 μ, four-spored. Spores globose, granular, 8-10 μ. Stem pallid, even, solid, fibrous-striate and slightly mealy below the annulus, above the annulus finely floccose, mealy. Annulus ample, membranous, persistent, white, 1 cm. from the apex. Volva thick, grayish brown, limb free.—C. U. Herb.

"On dead branches in woods beyond Forest Home, near Ithaca, N. Y., autumn, 1898. Name published with a few non-diagnostic notes, in Rep. N. Y. State Bot. for 1904, Bull. 94, N. Y. State Mus., p. 19, 1905."

I have examined the spores of the type plant of *A. lignophila* and find them spherical, 6.6-7.5 μ by my measurements.

10. **Amanita mappa** var. **lavendula** n. var.

PLATES 22, 23 AND 64.

Cap from 3.5 to 8 cm. in diameter, flat or slightly depressed in center (sometimes slightly gibbous in center) a light but distinct primrose yellow (not the dull egg yellow shades of *A. russuloides*), often with stains of light brown, lavender, purple lavender, or a combination of these; somewhat viscid when damp, shining when dry, smooth except for the occasional flat, irregular, lavender or pink-lavender patches of the volva. Margin distinctly striate when mature, or the striæ may be scarcely visible until the margin begins to dry. Flesh nearly white, sometimes quickly turning to shades of lavender when cut, quite thin, only 2 mm. thick at center of gills, smell when freshly cut like raw green peanuts.

The gills are pure white, free but close to the stem and connected by a line which runs down a little way, deepest near their middle, where they are from 3.5 to 7 mm. deep according to the size of the plant; many short ones, none forked.

Stem up to 10 cm. long and from 6 to 10 mm. thick in center, smooth and somewhat silky-shining, faint primrose yellow above and nearly white below the veil, but often with cream, brown, or lavender tints, and brown where bruised, solid but sometimes nearly hollow from the separation of the looser central fibers, no distinct central cylinder.

Bulb large and abrupt, but variable, sometimes 2.8 cm. in diameter, soft and spongy generally with an abruptly truncated top, which may be quite smooth or show slight marginal projections representing the volva. There is no volval cup. The surface is a distinct lavender color, sometimes pinkish or brownish lavender or rarely nearly white (as in No. 1399, but even in this collection the volva patches on the cap were lavender), internally it is white.

The veil is primrose yellow, thin, delicate, but not flocculent or friable, the lower side often showing the fibers by which it was attached to the stem. It breaks away perfectly from the cap edge and remains attached to the stem from 2 to 3.5 cm. below the cap, generally collapsing tightly against the stem, and so delicate at times that it is scarcely noticeable on the mature plant except where its free edge marks out a colored line against the stem. At other times the veil remains expanded for some time as a perfect skirt, and is quite perfect in the mature plant. Above the veil the same yellow tissue covers the stem to the cap, but as the stem elongates this tissue becomes scattered and also fades in color.

The spores are white, spherical, with a slight umbo. They vary considerably in different plants. Those from collection No. 399 average about 10 μ; those from No. 410, about 6.5 μ in diameter; and in No. 570, from 6 to 7 μ.

Not rare in pine or mixed pine and deciduous woods, or on rotting pine wood. As the typical *A. mappa* is poisonous, it is probable that our variety is also.

Our Chapel Hill plant is evidently near *Amanita mappa* Fr., and in stature and general appearance closely resembles that species, particularly the drawings of it given by Lucand in Champignons de France, folio 51. 1881. It may be sharply distinguished from the typical European *A. mappa* by the lavender volva and the primrose-

yellow veil. Beardslee finds *A. mappa* at Asheville and describes it as having a "yellow or pallid" cap, and he writes me that the veil, as he remembers, was primrose-yellow. He has no record of a lavender volva. In the Curtis herbarium there is a plant of *A. mappa* from the Santee Canal, South Carolina (Ravenel No. 1161), in which the veil is described as yellowish. There is no reference to a lavender volva. In Europe the cap is said to be variable, usually white or yellowish. I can find no published reference to a yellow veil. Our plant is so constant and distinct as to require at least a varietal name.

In all probability having the poisonous qualities of the typical plant.

165. Battle's Park, October 2, 1909.

166. Battle's Park, near leaning tree, November 2, 1909.

399. Woods, October 26, 1911. Photo.

410. In pine woods, southeast of campus, November 7, 1911. Photo.

427. Battle's Park, mixed woods behind Dr. Wilson's, September 24, 1912. Photo.

430. Battle's Park, mixed woods behind Dr. Wilson's, September 24, 1912. Photo.

510. Woods east of school house, October 5, 1912.

570. Along Howell's branch, above ravine, October 17, 1912.

590. Along Howell's branch and along branch from toward Strowd's, October 18, 1912. Photo. Color of cap primrose yellow tinted with green and lavender.

644. On a rotten pine log, Lone Pine Hill, October 26, 1912.

853. In dense pine grove, southwest of old brick yard in Tenny's meadow, September 18, 1913. Spores of this collection were spherical, pure white, 5.5-7 μ in diameter. Bulb was light pinkish lavender, purplish lavender stains on cap, no volva patches on cap.

1355. Woods south of campus, October 15, 1914. Spores white, spherical, with mucro, smooth, granular appearance, 6.4-9 μ.

1399. On bank above branch 1/8 mile below Meeting of the Waters, October 21, 1914. Photo.

1430. Woods near Emmerson's Dam, Bowlin's Creek, October 26, 1914.

1432. Woods by Battle's branch a short distance above first bridge, October 27, 1914. Photo. A very fine plant 8 cm. in diameter and a distinct lavender bulb and cap patches, a fine veil of clear primrose yellow.

1924. In mixed woods ¼ mile southwest of graded school, October 25, 1914.

1971. In a rotten stump in woods below Mr. Strowd's, November 8, 1915.

11. Amanita gemmata (Fr.) Gill.

A. junquillea Quél.	*A. crenulata* Pk.
A. russuloides Pk.	*A. glabriceps* Pk.
A. nivalis Pk.	*A. phalloides striatula* Pk.
A. velatipes Atk.	*A. multisquamosa* Pk.
Amanitopsis albocreata Atk.	*A. amici* Gill.

PLATES 24 AND 65.

Plants very common in woods and not rare in shaded lawns, especially if recently manured; gregarious and often crowded, varying from very small to moderately large, the cap being up to 8.8 cm. broad, and the stem up to 12 cm. long. Cap shining and viscid or becoming dry in dry weather and usually with a few or many soft white volva patches, which, when small, tend to be pyramidal; edge very distinctly tuberculate-striate; color usually a light egg yellow, varying to creamy tan or brownish tan or grayish brown, fading to straw or pallid on the edges as the plant ages; occasionally very small plants will be very light, even in youth. Flesh thin, white, usually odorless, but sometimes, as in collection No. 693, with a decided odor of smoked ham.

Gills white, not much crowded, broadest at marginal end where they are 6-7 mm. deep, close to the stem and attached to it by a line, connected at the very thin pileus by obvious raised veins. Their margins when young are delicately flocculent from the fine fibers that connected them to the stem. The inner ends of the short gills are squarely truncate as in *A. cothurnata*.

Veil, when present, white, thin, not hanging like a shut umbrella as in *A. phalloides*, but forming an extended ring which is attached from 1.5 to 4 cm. below the cap; more often than otherwise it is entirely absent, the plants then simulating an Amanitopsis.

Stem 5-12 cm. long, usually tapering upward, the base enlarged into a bulb; stuffed in center; surface white, smooth toward the top except for the descending lines from the gills; below it is more or less fibrous and often split and slivered on the surface. The bulb is rather abrupt, occasionally quite smooth, but usually marked at the stem base by the slight or conspicuous remains of the volva.

consisting of a perfect or fragmented collar, which sometimes is found at a considerable distance up the stem; occasionally the collar is thicker and more rounded, approaching the appearance of forms of *A. cothurnata.*

Spores short-elliptic to subspherical, smooth, with a large oil drop, rather variable in size, usually about 7.4-8 x 10-11 μ.

Edible in all probability. Ford and Brush find that extracts of *A. junquillea* contained no hæmolysin and were entirely free from poisonous action upon both rabbits and guinea pigs, and are inclined to regard the species as free from poisonous properties (Jour. Phar. and Exp. Ther. **6**: 193. 1914). *A. russuloides*, which is the same, was also found to be harmless by Ford (Jour. Phar. and Exp. Ther. **1**: 284. 1909). On the other hand, Ford finds that *A. crenulata* contains a small amount of a poison like that in *A. phalloides,* killing guinea pigs and rabbits (Jour. Phar. and Exp. Ther. **2**: 294. 1910). Peck reports that *A. crenulata* has been eaten without harm. McIlvaine says of *A. nivalis* Grev. (probably meaning *A. nivalis* Pk.) that it is harmless, but bitter when cooked.

Colored illustration: Murrill, Mycologia **8**, No. 5, Plate 190, Figs. 2 and 3. 1916.

In the behavior of the veil this species is most unusual. Peck (Rep. N. Y. St. Mus. **25**: 73. 1873) says that the annulus is thin, soon vanishing; and Beardslee (Jour. E. Mitchell Sci. Soc. **24**: 124. 1908) finds the Asheville plants to have no annulus or a very rudimentary one. In our plants, while the veil is probably more often absent, it is frequently conspicuous and permanent.

In size, shape and general appearance this species is most like *A. cothurnata,* and in some cases, where the volva rim is low and even, the similarity is great, especially as the volva rim of *A. cothurnata* is not always so rounded or neatly rolled as the descriptions call for. This may be seen in one of the plants in Atkinson's figure 68 of *A. cothurnata* (Plate 17, Mushroom Book), and my photo of No. 510.

A. gemmata is our only Amanita that is partial to manured soil.*

* With the possible exception of *A. hygroscopica,* which has been found so far only in cultivated and manured soil around evergreens.

It is very near *A. cothurnata* (see remarks under that species), but typical forms may be distinguished from that species by the *gills not being remote from the stem but attached to it by a line,* and the volva not forming a neat and even roll. The egg yellow color of the former is usually also distinctive, but in pale forms will not help. The spores do not form a means of distinction.

I have followed Beardslee and Maire in considering *A. junquillea* Quél. the same as *A. russuloides* Pk., and Maire in considering both of these as synonyms of *A. gemmata* (Fr.) Gill. For still other names for this plant see Maire, Annales Myc. **11**: 334. 1913. Bressadola, Boudier and Rea have all seen Beardslee plants and unite in referring them to *A. junquillea.* The good figure accompanying Boudier's discussion of this species in the Bulletin of the French Mycological Society **18**: 253, cannot be distinguished from our plant.

Our plate No. 24 shows variations in a lot of plants from one colony, but does not show the larger plants called by Atkinson *A. velatipes* (Studies of Am. fungi, p. 63). Such large plants are common here, together with a complete set of intermediates, and show the same peculiarities in the behavior of the volva. The peculiar volval rings mentioned by Atkinson, that may be found at some distance above the bulb, are often seen in our plants whether with or without a true annulus higher up. I have examined the type plants of *A. velatipes* and find the spores and other characters the same as in ours. I have also examined the types of *A. glabriceps* Pk. (N. Y. St. Mus. Bull. **131**: 18. 1909) and *A. multisquamosa* Pk. (N. Y. St. Mus. Rep. **53**: 840. 1899), which is a light form, and find them just like *A. gemmata.* The spores, too, are identical with the latter in both cases. In his description of *A. glabriceps,* Peck states that his *A. phalloides striatula* is a form of that species. *Amanitopsis albocreata* Atk. (Jour. Myc. **8**: 111. 1902) and *Agaricus nivalis* Pk. (Rep. **33**: 48. 1880) are also almost certainly *A. gemmata.* Miss Eaton's colored figures of *Venenarius (Amanita) glabriceps* and *Vaginata (Amanitopsis) albocreata* are just like our plants (Murrill: Mycologia **8**: No. 5, Plate 190). *A. crenulata* Pk. is a form with rudimentary veil and

subspherical spores. I have measured the spores of the type and found them 6-6.7 x 7-7.8 μ (see Plate 65). It is reported as edible. In a later note (N. Y. St. Mus. Bull. **94**: 19. 1905) Peck refers to this plant with more striate margin and more yellow cap. The type was described as being whitish or grayish, sometimes tinged with yellow, the margin somewhat striate (Bull. T. B. C. **27**: 15. 1900).

146. Low place east of athletic field, September 25, 1908.
419. Oak grove at "The Rocks," September 19, 1912. Cap a clear egg yellow. No veil. Spores 5.5-7 x 7-9.3 μ. See drawing.
429. Mixed woods, Battle's Park, behind Dr. Wilson's, September 24, 1912. Cap a clear egg yellow; the volva collar about 1 cm. above base of stem.
430. Woods, Battle's Park, east of Dr. Wilson's, September 24, 1912. Photo.
511. Woods east of school house, October 5, 1912. The volva in this collection acted in a very confusing way. Portions of it were often stripped off a good way up the stem, so as to simulate a veil or ring. Others were entirely devoid of any volva remnants, except at the base. Spores about 7.4 x 11.2 μ.
693. Dr. Wagstaff's shaded lawn, July 15, 1913. Very abundant. Spores elliptic, 7-8.7 x 9.2-11.8 μ. The plants of this collection varied from 2.2-9.5 cm. in diameter of cap; veil present, forming a durable annulus. A distinct smell of old ham. The lawn had been well manured last fall. A few plants of this species were found to-day on the campus in grass near alumni building.
709. Woods near branch in Battle's Park, July 20, 1913. Not uncommon now
735. Rich woods west of "The Rocks," September 11, 1913. Photo. Just as in collection No. 511. Spores elliptic, variable, most about 6.6-7.5 x 9-11 μ; a great many larger, up to 11 x 13.7 μ.
750. Woods near Meeting of the Waters, September 12, 1913. Just like No. 735.
1095. Dry woods east of cemetery, July 8, 1914. A clear and beautiful light yellow in center.
1334. Battle's Park, north of the cemetery, near road to Piney Prospect, October 13, 1914. Spores smooth, white, elliptic, 7-7.8 x 10.3-11 μ.
1353. Woods just south of campus. Spores elliptic, with lateral mucro at one end, sometimes one large oil drop, often several smaller ones, smooth, 5.5-8.5 x 6.4-11.9 μ.
1706. In soil among trash piles in woods just south of graded school, September 8, 1915. Photo.
2046. In grass under trees by Gimghoul Lodge, June 9, 1916.
2054. In manured borders in Dr. Brown's yard, June 11, 1916. Photo. Spores 5.2-6 x 7-7.8 μ, a few larger or smaller. (Drawing.) Some of these plants were very large, and all had veils.

Asheville, very common (as *A. junquillea*). Beardslee.
Flat Rock (as *A. russuloides*). Memminger.

12. **Amanita cothurnata** Atk.

A. pantherina Fr. (?)

PLATES 25, 26 AND 65.

Cap up to 7 cm. broad, usually about 4.5-5.5 cm., plane or the margin turned up, viscid, the margin distinctly tuberculate-striate, marked with irregular patches or warts which are easily removable and often washed away. The color is quite characteristic and with us is very constant. It is a pallid white on the margin, shading gradually to a light pallid buff in the center (the immediate center becoming more abruptly darker); only occasionally, as in collections No. 1123 and No. 1725, is the color pure white all over or only the center creamy. Flesh membranous at margin, about 4.5 mm. thick at stem, pure white.

Gills rather crowded, distant from stem and not connected with it by a line, and no lines on top of stem, much broader near the rounded distal end, where they are about 5 mm. deep, veined by lines at the cap. There are a good many short marginal ones which are remarkable for their squarely truncate inner ends.

Stem about 7-11 cm. long, and 2-7 mm. thick near top, enlarging gradually downward and terminating in a distinct bulb. Surface of stem white, very smooth above, often fibrous below. A distinct central cylinder is present and is lightly stuffed or nearly hollow.

Veil thin, membranous, smooth above, softly felted below, often irregularly torn in expanding, usually remaining as a more or less perfect ring on the stem 1-4 cm. from the cap. Universal veil, pure white, completely fused with the bulb and sticking to the cap as more or less persistent warts, leaving as a rule a very distinct and thick rolled margin at the top of the bulb, but sometimes with a thinner, more irregular and less characteristic margin.

Spores white, elliptic, smooth, 6.6-7.8 x 7.6-11 μ.

Colored illustration: Murrill, Mycologia **5**: Plate 87, Fig. 6, 1913.

This species is very near *A. pantherina* Fr. of Europe and may

be identical. The "usually white" color that Atkinson gives as a character of *A. cothurnata* does not hold in this locality, though the cap is occasionally white here and is usually white at Asheville (Beardslee, Jour. E. Mitchell Sci. Soc. **24**: 118. 1908). The white plant from New York called by Peck var. *albescens* of his Oregon species *A. calyptrata* (N. Y. St. Mus. Rep. **53**: 840. 1899) is almost certainly this. The yellowish color mentioned by Atkinson as occurring at times is the rule here. The spores are given as globose or nearly so by Atkinson, but they are really short elliptic as Beardslee states (Jour. E. Mitchell Sci. Soc. **24**: 119. 1908), and as often confirmed by me. I have examined spores from a plant collected by Atkinson at Blowing Rock and find them as in our plants, 6.6-7.5 x 9.3-10 μ, most about 7.4 x 9.7 μ. See drawing. They are filled with a very large conspicuous oil drop, as Atkinson notes, which makes them appear more globose than they really are. Spores of *A. pantherina* collected by Beardslee in Sweden were examined by me and were found to be identical with old spores of my collections of *A. cothurnata*, and contained a similar large oil drop, which in both species was usually eroded, much as a starch grain is when being digested. The spores of this Swedish plant were 7-8 x 8.5-11 μ.

Poisonous (?). There seem to be no edibility records for this, but it poisons flies (Mycologia **2**: 259. 1910), and *A. pantherina*, which is very near if not the same, is known to be poisonous like *A. muscaria*, but in milder form (Mycologia **2**: 261. 1910). However, working on plants from Stow, Mass., Ford and Sherrick report that extracts "were without effect upon blood corpuscles and exhibited no toxic action upon rabbits or guinea pigs" (Jour. Phar. and Exp. Ther. **4**: 326. 1914).

Among our own Amanitas *A. cothurnata* is most like *A. gemmata* in general appearance, and after seeing hundreds of plants of both species, I am doubtful if they are sharply distinct. The neatly rolled volval margin and straw-colored cap of *A. cothurnata* varies into the thinner and more torn volva and deeper yellow cap of *A. gemmata*, and those, with usually more remote gills, are the only points of difference that I can find. The deeper yellow color

seems to accompany a richer soil. Miss Eaton's drawings of *Amanita* species, determined by Murrill as *A. glabriceps* and as *Amanitopsis albocreata* (Mycologia **8**, No. 5, Plate 190. 1916), cannot be distinguished from our *A. gemmata,* while Peck's figures of *A. glabriceps* (Bull. N. Y. State Mus. **131**: Plate U. 1909) are very like *A. cothurnata,* as figured by Atkinson (Studies of American Fungi, Figs. 68, 69, 70), except for the absence of warts, and these are frequently lacking in the latter.

427. Battle's Park, back of Dr. Wilson's, September 24, 1912. Caps pallid cream, center smoky cream. Photo.

430*a*. Battle's Park, behind Dr. Wilson's, September 24, 1912. Photo. Cap pallid smoky cream, ring not collapsing but standing out horizontally.

510. Woods east of school house, October 5, 1912. Two photos. In this collection the annulus when young and perfect looked like a hat and did not hang down. Cap a light pallid yellowish or brownish tan, usually with volva patches. Gills pure white; spores short-elliptic, a large oil drop, 7.4 x 8.3 μ.

551. Open woods, Battle's Park, October 10, 1912. Spores short-elliptic, averaging about 7 x 8.8 μ.

1116. Woods, Battle's Park behind Mrs. Gore's house, July 11, 1914. Spores elliptical, 7-7.4 x 8-9.6 μ.

1123. Sandy soil by Morgan's Creek below King's Mill, July 12, 1914. Photo. Cap pure white, or creamy white in center.

1144. Near shrub by road in Dr. Venable's lawn, July 15, 1914. Photo (with No. 1145).

1145. Under bushes between road and campus near east gate, July 16, 1914. Photo (with No. 1144).

1316. Battle's Park, northwest of Brockwell's spring, October 9, 1914. Spores elliptic, 6.6-7.8 x 8.8-11 μ.

1337. Battle's Park, north of cemetery, October 13, 1914. Spores when fresh elliptic, 6.8-7.6 x 7.6-10 μ. Measured again after more than a year, results were 6.6-8.1 x 7.4-10 μ, some not far from spherical, but great majority distinctly elliptic.

1354. Woods south of graded school, October 15, 1915.

1553. In mixed woods south of athletic field, June 18, 1915. Spores 7.2-7.6 x 7.6-9 μ.

1647. In leaves under a beech tree near Battle's branch, July 26, 1915. Pallid tan in color.

1725. Among leaves, open woods east of east gate of campus, September 10, 1915. Photo. These plants were very light colored, several being almost pure white except for a small creamy or buffy spot in center.

1754. In woods half way up Lone Pine Hill, September 12, 1915. In two of these plants the veil was on the middle of the long stems, about 6 cm. from the cap.

Blowing Rock. Atkinson.
Asheville. Beardslee.
Flat Rock. Memminger.

13. **Amanita muscaria** Linn.

Venenarius roseotinctus Murrill. *A. onusta* Howe.

PLATES 27, 28 AND 65.

Cap from 3.2-11 cm., usually 6-8 cm. wide in Chapel Hill; at the north and in our mountains averaging somewhat larger; surface adorned with soft, flat or warty patches of ashy gray or light yellow color which may be absent over considerable areas and occasionally entirely washed off in rainy weather; between these patches the surface is smooth, shining, and viscid when moist; margin usually not striate, but often, especially in small plants, distinctly so; color usually some shade of salmon, a fine rosy salmon in center fading to light yellowish salmon on margin or red salmon in center and orange salmon on margin. In large plants, which are rare in Chapel Hill but common in the North, the color is darker, being a deep orange red, about mars orange or lighter orange. As the plant ages the color may fade until it becomes a very light pallid salmon or even an ashy gray. Peck says that the plant may at times be wholly white, and calls such forms var. *alba* (N. Y. St. Mus. Rep. 33: 44. 1880). Flesh up to 1 cm. thick at stem, very thin toward margin, a clear yellow near the surface, a light yellow or cream inside.

Gills rather close, just reaching the stem and usually slightly adnexed, broadest near the margin where they may be 9 mm. deep, pointed at stem, rounded at margin, color almost pure white, faintly yellow and dotted on the edge when fresh with *sticky particles,* connected with veins at the cap. The short gills have the free end cut off squarely, perpendicular to the cap (truncate).

Stem 5.5-14 cm. long, 5-15 mm. thick at top, nearly even to the strongly bulbous base, almost white or ashy brown, light yellow and with a quite sticky powder above the veil when young, smooth

or somewhat fibrous-flocculent below, loosely stuffed or hollow, enlarged below to a short oval bulb, which is a brownish ash color. The bulb may be almost smooth, but is nearly always marked on the upper third by small and large lines and ridges of the volva, and these may extend some way up the stem.

Veil thin, usually yellowish, sparingly fibrous below, usually attached from 2-3 cm. from the cap, but sometimes lower, thicker and deeper colored on the margin. It separates from the cap and holds to the stem as a perfect ring or as a number of partial rings and fragments, or may be so torn as to fall away entirely. In depauperate forms the veil may be entirely absent (see description of No. 1794). When perfect the ring is quite handsome with its thick ashy brown crimped margin and perfect form. Rarely the volva markings on the bulb take the form of a low but distinct membranous margin.

Spores (of No. 880) creamy white in bulk, elliptic, smooth, 6.3-7 x 7.5-8.1 μ.

Deadly poisonous; but atropine is an antidote.

Colored illustrations: Taylor, in Rep. of the Sec. of Agri. for 1892, Plate 2; Atkinson, Mushrooms, Plate I. Fig. 1; Marshall, Mushrooms, Plate opposite page 41; Murrill, Mycologia **5**: Plate 87, Fig. 3, 1913; Gibson, Our Edible Toadstools and Mushrooms, Plate 4, p. 55.

These plants are particularly fond of dry pine woods, occurring rather frequently in groups in pure pine or in mixed pine and deciduous woods, and very rarely (No. 1388 and No. 1794) under oaks alone. It may be found year after year in the same spots.

This is *Venenarius roseotinctus*, Murrill, which is established on rather small specimens of salmon color, found in sandy soil in mixed woods at Biloxi, Miss. The southern tendency in the species is toward a smaller size, salmon color, and pine-loving habit. Both extremes occur here and are connected by a complete series of intergrading forms.

I have no doubt that *A. onusta* Howe (Bull. T. B. C. **5**: 42. 1874) is this species, the veil in the plant described being more ephemeral than usual, though the plants were not dwarfed as de-

scribed for the form below. The gray warts, even margin, concentrically squamulose bulb and especially the *viscid, farinose* stem exclude all other species and agree with this. The brownish gray cap is not exclusive. The plant referred by Peck to *A. onusta* (N. Y. St. Mus. Rep. **53**: 839. 1899) is not that species, but a form of *A. chlorinosma.*

67. Mixed woods, Battle's Park, October 28, 1910.
173. Dry pine woods, side of road by cemetery, October 24, 1910. Spores elliptic, 8 x 11 μ.
408. Near path under pines at foot of old volcano on east side, October 29, 1911. Several photos. Large plants; spores 7-7.7 x 10.3-10.8 μ.
544. Battle's Park, October 10, 1912. Photo. The margins of these plants were strongly striate.
880. In dry, poor pine and oak woods by side of road about 300 yards southeast of cemetery, October 5, 1913. Three photos.
884. By path cutting through woods just beyond Morgan's Creek on the road to Smith's Level, October 5, 1913.
885. By path near the foot of the "Volcano," east side in pine woods with dogwood underbrush, October 5, 1913.
1135. Campus in grass north of soldiers' monument, July 13, 1914.
1388. At foot of black oak just north of alumni building, October 19, 1914. This plant was 7.2 cm. wide, a light salmon clay color. Stem sparingly granular-flocculent. Short gills squarely truncate at free end Spores nearly white, elliptic, smooth, 6.6-7 x 7.7-9.6 μ.
1442. In bank beside road in hollow, about a mile southwest of cemetery, October 28, 1914.
1540. In poor sandy soil, pine and oak woods near east gate of campus, June 7, 1915.
1911. Under pines, Piney Prospect, October 21, 1915. Photo. Large red plants, small salmon forms, and intermediates. Spores 6.3-8.1 x 7.4-10 μ, a few smaller.
1953. Hillside north of King's mill dam, under *Pinus virginiana*, October 31, 1915. Two photos. Spores short elliptic, smooth, granular looking or the oil gathered in a large drop, 6-7.6 x 8-10 μ.

Asheville, rather rare. Beardslee.
Blowing Rock. Atkinson.
Flat Rock. Memminger.
Middle district in woods (Schw.). Curtis.

13*a*. **Amanita muscaria** Linn. Depauperate form without veil.

PLATE 29.

Cap up to 8 cm. broad, strongly depressed in center, margin nearly plane and finely striate for 5-7 mm., surface with rather

low, sharp, pyramidal warts, about 1-1.5 mm. thick at base, the margin and cap surface between the warts more or less finely flocculose-scaly, color a light creamy tan. Flesh white, soft, 3 mm. thick at stem, a membrane toward the margin.

Gills crowded, creamy, just reaching the stem, 8 mm. wide in middle, rather pointed toward the margin, the short ones squarely truncate, glutinous on the edges which are granular dotted (sub-eroded).

Veil entirely absent, or making a faint circle on the stem.

Stem, including bulb, 5.5 cm. long, 1 cm. thick near center, expanding at cap and enlarging downward to an oval bulb, which is margined on the neck by several rows of little cogs. Surface of stem cream color, the superficial layer *strongly glutinous*, bulb below the cogs *not* so.

Odor of plant not strong, but noticeable and like slightly spoiled ham, not the chlorine odor of *Amanita chlorinosma*.

Spores spherical to subspherical, white, smooth, 7.2-10 μ in diameter.

Stems of typical *muscaria* are also sticky, but they are usually not so intensely glutinous as in these aberrant plants, which are so sticky that the whole plant can almost be lifted by touching the finger to the stem.

Even large plants of *A. muscaria* may have an ephemeral veil, that does not form a ring on the stem. Such a form is *A. onusta*, which is intermediate between this and the typical plant.

1794. In dry sandy soil with sparse grass, in Dr. Venable's lawn, September 11, 1915. Two plants, one 8 cm. wide and one stunted and cracked by dry weather and only 2.8 cm. wide.

1967. Poor sandy soil, pine woods, on road to Mason Farm, November 7, 1915. This is just like No. 1794 except for a faint salmon tint, and traces of a veil on the margin: 5 cm. wide and 5 cm. high. Spores elliptic, smooth, 6.6-7.7 x 11-11.8 μ.

1979. In dry pine woods north of Brockwell's, November 12, 1915. This is intermediate between the above and the typical *muscaria*. Cap only 2.5 cm. wide, mostly white; veil very delicate, drying up on the gills; gills and stem above very viscid; stem only 1.5 cm. long above bulb.

Asheville, rather rare. Beardslee.

14. **Amanita spissa** Fr.

A. Morrisii Pk. *A. submaculata* Pk.

PLATES 30, 31 AND 66.

Cap 4.5-8.5 cm. broad, plane or slightly convex, sometimes gibbous, slightly viscid, usually with rather few, scattered, soft, thickish, gray or brownish-gray warts, at times quite free from warts; margin even or irregular, usually smooth, but sometimes lightly striate for about one cm., rarely faintly flocculent; color typically Saccardo's umber in center, the margin lighter, but varying to wood-brown or blackish umber in center and vinaceous-buff or pallid umber on margin. Flesh pure white, not changing when cut, thin, 3-4 mm. thick near center, quickly thinning to a mere membrane on margin, odorless and almost tasteless, at times somewhat astringent.

Gills pure white, moderately or distinctly crowded, few or many short ones, just reaching the stem by a point and with a descending line, narrow, usually 3-5 mm. wide, rarely up to 9.5 mm. wide in large plants, very light on drying.

Veil ample, thin, not friable, pure white on both sides or brownish below, lined above by the gills, hanging as a skirt about 5-15 mm. from the cap, and usually soon collapsing against the stem.

Stem 6-11 cm. long, 8-14 mm. thick near center, nearly equal or tapering upward, almost smooth or below the veil fibrous, ending below in a tapering or rather abrupt bulb of variable size, which is rather firmly set in the ground; there is usually no trace of a volva on the bulb, but there may be a few flat, inconspicuous lines or ridges or powdery particles near the top; color of stem white above the veil, varying below from grayish umber or wood-brown to white. Flesh solid, firm, elastic, no central cylinder, very rarely somewhat hollow above.

Spores usually very variable in size in the same plant, smooth, white, a large oil drop, elliptic, with an eccentric mucro, 4-6.7 x 6.5-9 μ, most about 5 x 8.3 μ, a few up to 8 x 11.5 μ. Some small spores are found in most plants, but in some the spores run consistently small (as in No. 2215).

This species has been reported but a very few times in America. It has been found twice and given two names by Peck. I have examined carefully his type plants of *A. Morrisii* and *A. submaculata* and find them the same. Peck describes the cap of *A. Morrisii* as smooth and so figures it, but several plants of his type collection have warts just like our *A. spissa*. A plant of *A. spissa* from Sweden, kindly sent me by Beardslee, is the same in all essentials. The species is most like *A. rubescens* and *A. excelsa*. From the former it is easily distinguished by its unchanging flesh and umber or wood-brown color; from the latter by its smaller size, less fibrous stem, much thinner veil, pure white gills, and less fragile flesh. The spores are the same as in *A. excelsa*.

Edibility not certain. It was eaten and pronounced savory by McIlvaine, but it is not certain that he had the same plant that I have referred to this species. Ford found to be edible a plant from Massachusetts thought by Peck to be intermediate between *A. rubescens* and *A. Morrissi* (Jour. Phar. and Exp. Ther. 6: 205. 1914). It was probably *A. spissa*. Later Ford reports that *A. Morrisii* has a small amount of poison and is toxic to guinea pigs and rabbits (Jour. Phar. and Exp. Ther. 2: 292. 1910).

548. Near Battle's Park, back of Prof. McKie's, October 10, 1912. Cap up to 7 cm. broad, smoky gray in center, exactly color of *A. spreta*. No sign of a volva anywhere except a few little patches above the bulb. Spores elliptic, averaging about 6.6 x 8.1 μ.

842. By Battle's Brook, September 25, 1913. Photo. Spores elliptic, very variable, 4.8-6.7 x 6.5-9.4 μ. Reddish stains on stem and bulb, bulb not emarginate.

930. In pine woods by path south of athletic field, October 18, 1913. Two photos.

Cap 7.5 cm. broad, flat, smooth, no warts, and not striate at all on the margin. Vinaceous-buff (Ridgway) except toward center, which shades to wood-brown, with several stained spots of a deeper chestnut-brown. The margin is distinctly inherently fibrous, and the remainder is mottled somewhat like a pheasant's breast, only rather indistinctly. Flesh of cap white, thin, about 2 mm., deep half way to the margin, unchanging. Spores white, smooth, elliptic, 4.5-5.5 x 6.5-7.5 μ.

1133. In grass on campus near monument, July 13, 1914. Spores elliptic.

1330. Lawn of "The Rocks," under oaks in grass, October 13, 1914. Photo.

Cap 8.5 cm. broad, flat, slightly striate for about 1 cm. on the margin, smooth and shining, a few scattered small flattish warts of a soiled gray

color, vinaceous buff on margin to avellaneous in center; flesh pure white except just under the surface, where it is color of cap, unchanging. Gills about 8 mm. wide in center, many short ones. Spores pure white, elliptic, 5-6.5 x 7.5-8.5 μ.

1344. In pine woods south of athletic field, October 14, 1914. This is exactly like 1330, except there was no meal on bulb. Color of cap and of volva patches is light vinaceous buff. Cap 7.5 cm. wide. Spores elliptic, 4.5-5.5 x 6.6-7.5 μ. Like those of No. 2260.

1987. Poor soil, mixed woods, Battle's Park, November 12, 1915. Photo.

Cap 5.8 cm. broad, flat, no volva patches, blackish umber in center, much lighter pallid umber toward margin. Gills rather crowded, 3.5 mm. wide, pure white and unchanging, their margins eroded. Veil ample, thin, smooth, upper side distinctly lined by the gill edges, white. Stem grayish umber below, white above the veil, solid, slightly bulbous, the bulb with several flat ridges. All parts unchanging when bruised. Spores smooth, elliptic, very variable in size, 4-5.2 x 6.3-8.7 μ.

2166. By western Meeting of the Waters branch, June 20, 1916. Spores 4.8-7 x 6.3-8.2 μ.

2178. By path by branch near Meeting of the Waters, June 21, 1916.

This is the form that was named *A. Morrisii* by Peck. Cap free of warts, Saccardo's umber in center; margin not striate; flesh not changing; gills crowded, narrow, white; stem slightly enlarged at ground, solid, white, but becoming brownish when rubbed. Veil becoming brownish below. Spores pure white, smooth, short-elliptic, 4.5-6 x 6.5-8.5 μ.

2194. Poor mossy soil under oaks in Dr. Venable's yard, June 21, 1916. Photo. Remarkable in having some of the stems hollow at the top; color Saccardo's umber, warts brownish gray. Spores pure white, smooth, elliptic, 4-5.2 x 6.6-8.1 μ.

2206. Mixed woods southwest of Mr. Pritchard's, June 22, 1916.

This is the form named by Peck *A. submaculata*. Cap up to 8 cm. wide, umber in center with a few flat, grayish volva patches on some and none on others, distinctly inherently fibrous toward the margin, but not at all striate except faintly on the fading margin of old plants. Gills up to 9.5 cm. wide in largest plant, and stem 11 cm. long, not hollow in age, and with no distinct cylinder in center; base enlarging gradually as in *A. rubescens*. Veil in some breaking and hanging to the margin. The cap of the largest plant shows the umber color somewhat mottled, and also shows the curious white dots that led to Peck's name. These dots are mostly about 1-1.5 mm. wide, elliptic to subspherical, and are due to the absence of the superficial layer at these points as if separated and pulled apart, without apparent cause. Such dots are present to a less extent in several other collections.

Spores 4.8-6.3 x 7.5-9 μ, most about 5 x 8.3, a few up to 8 x 11.5 μ.

2215. Under oaks, lawn of "The Rocks," June 24, 1916. Two plants, one 8.5 and one 9 cm. broad; surface rather pale umber and only slightly lighter on margin, which is inherently fibrous and faintly striate, only

a few scattered white spots, sunken dots, and a very few small particles of the volva. Gills, veil, stem, etc., as described for other numbers. Spores 4-4.5 x 6.5-7 μ.

2220. Under oaks by Gimghoul Lodge, June 24, 1916. White on marginal half, ochraceous umber in center, with conspicuous and large, flat, grayish brown warts. Spores white, elliptic, smooth, 4.4-7.4 x 7.4-11 μ.

2260. Lawn of "The Rocks," June 26, 1916. Spores average about 4.4 x 7 μ.

2274. Lawn of "The Rocks," June 26, 1916. Spores average about 4.4 x 6.7 μ.

15. **Amanita spissa** var. **alba** n. var.

PLATE 66.

Cap about 7.5 cm. broad, gibbous in center, the margin plane or slightly elevated; surface pure white, dull or faintly shining, slightly viscid, damp, marked with the same deep little pits and shallow larger pits that so often appear on *A. spissa* in North Carolina, two or three small flat patches of the volva which is apparently white at first, then brown on drying; margin striate for about 0.5-1 cm. Flesh soft, white, only about 5 mm. thick in center, tasteless and odorless, not reddish when bruised.

Gills hardly crowded, just free, nearly pure white (faintly creamy), broadest in middle where they are about 8 mm. wide.

Veil nearly apical, very thin and delicate collapsing into a thin brownish-dusky membrane against the stem.

Stem about 3½ inches long, smallest in center; surface lightly fibrous, white then brownish when handled, soft-fibrous in center, but not hollow or with a distinct central cylinder, base with a small oval bulb with a few faint flat patches of the brownish or pinkish-brown volva.

Spores elliptic, smooth, a decided, eccentric mucro, 4.2-5 x 6.3-7.5 μ. Drawing.

This is just like *A. spissa* except for the pure white color. The brownish stains on the stem, when rubbed, are also often noticed on the typical plant.

Hartsville, S. C. (No. 11). Flat woods under long-leaf pine, Ellis place, southeast of Hartsville plantation, September 9, 1916. Plants lost, but spore print saved.

16. **Amanita excelsa** Fr.

Amanita ampla Pers.

PLATES 32, 33, 34, 35 AND 67.

Cap up to 15 cm. broad, at first convex, then plane or the margin elevated, surface dull or slightly shining, moderately or scarcely viscid, and with a separable cuticle, usually smooth at maturity except for scattered warts, which are usually thick and flat or bluntly pyramidal and rather irregular in size, about 3-8 mm. in diameter. When young and undisturbed the margin is covered with a soft, easily removed flocculence which shades into warts. Margin sometimes striate for about 1 cm. when mature, more often not striate. Color a smoky tan or straw, about drab, in center, a very light pallid straw, almost white, on marginal half. Flesh white, soft and very fragile, about 1 cm. thick at stem, odorless.

Gills fleshy, white, rather crowded, narrow, about 6 mm. wide, narrowed toward the stem, just reaching it when young, detached or even remote when mature.

Stem up to 10 cm. long above ground, usually stout, tapering upward, bulbous or scarcely enlarged below, lightly or deeply rooted; surface smooth above the veil, decidedly fibrous-flocculent below it, or becoming smoothish toward the base, white, or the flocculence sometimes creamy buff or light salmon color. Bulb without volva patches, or more or less marked on the top by soft, obscure ridges and flakes. It was noticeable that the first plants to appear in the summer of 1914 (July 15th, about) after a long drought were much more deeply rooted than was usual in the fall. Flesh of stem solid all through with no stuffed central cylinder.

Veil usually attached about 1-1.5 cm. from the cap, but at times almost at the very apex, fairly thick when young, with a thicker marginal roll, thinner in age, flocculent below, exactly as in *A. spreta* and acting exactly as in that species, *i. e.*, perfect and ample at first, but fading and collapsing to a membrane against the stem, or, unlike *A. spreta*, often breaking and falling off on account of its fragility; color pure white or the flocculence and marginal roll creamy buff or light salmon, not turning smoky.

Spores pure white, elliptic, averaging about 5×8 μ, with or without an oil drop when fresh.

The plants are usually very large, but are fragile throughout, more so than any other of our Amanitas. They are rather common in dry woods, mixed and deciduous, in sandy loam or clay.

Fries states that *A. excelsa* is poisonous, but Mrs. I. M. Jervey, of Arden, and her friends have eaten for years the plant described above. The evidence as to the edibility of many species is contradictory.

This species is nearest *A. spissa,* which see for points of distinction. After examining the illustrations of *A. excelsa* by Gillet (as *A. ampla*), Cook, Paulet and others, I am satisfied that our plant is the same. Fries gives the habitat as pine woods.

The species seems to have been reported from America only by Curtis, but the plant so labeled in the Curtis herbarium is not *A. excelsa,* but *A. chlorinosma,* which is obvious from its appearance and from Curtis' note, "odor gravis."

From the *solitaria* group the species is separated by much greater softness and fragility, by separable cuticle, simpler and more fragile veil, and characters of the bulb; from the *strobiliformis-chlorinosma* group it differs in greater fragility, separable cuticle, flesh-color of the gills, and absence of chlorine odor.

514. Woods east of school house, October 5, 1912. Photo. Spores 4.8-6 x 6.6-8.5 μ. Drawing.

521. Woods across small branch south of campus, October 7, 1912. Photo.

736. Mixed woods south of athletic field, September 12, 1913. No volva marks on bulb or only a few lines; cap when young drab in center, light drab or almost white on margin, in age fading to pallid shades of brownish grays and yellows. Spores white, elliptic, 5.5-7.4 x 7.4-9.2 μ.

755. Mixed woods east of graded school, September 13, 1913. One of these two plants was pure white, our first pure white specimen, the other was white on margin, light smoky gray in center. Stem quite flocculent from veil to near base; no free volva, only delicate lines on and above bulb; veil thin, fibrous-flocculent below, hanging about 1.5 cm. from cap; scarcely any volva patches on cap; edge not striate.

794. Battle's Park, September 19, 1913. Photo. In many plants of this species brought in during the last few days (collection No. 794 is part of these) the veil has been a delicate light salmon color on the thick outer edge, often all over on under side, only lighter. At the margin of the cap

the veil is thicker, and this thick ring breaks up in expanding into patches as shown in photo of No. 521. These patches are the most strongly colored. Veil fibrous-flocculent beneath, not at all pulverulent as in *A. chlorinosma* and not so fragile as in that species. Stem without a central cylinder, but often fibrous inside and frequently riddled by grubs. Spores, white, elliptic, 4.6-5.5 x 5.5-7.4 μ in one plant; 4.6-5.5 x 6.5-9.2 μ in another; 5.5-7.4 x 7.4-8.3 μ in another; and 4.6-6.5 x 8.3-10.3 μ in another.

903. Battle's Park, near path to Piney Prospect, October 8, 1913. Photo. Spores 5.5-7.4 x 7.4-11 μ.
1098. Battle's Park, at edge of corn field, just south of Dr. Battle's house, July 8, 1914.
1141. Oak grove east of Arboretum, July 16, 1914. Photo.
1571. On ground by path along Battle's branch, June 22, 1915.
2111. In clay by road to Purefoy's Mill, June 14, 1916.
2117. Under oaks in front of Gimghoul Lodge, June 16, 1916.

Arden, September 23, 1915. One fine fresh plant sent by Mrs. I. M. Jervey, who says that the plants are edible and that she eats them regularly. Spores 5.1-5.5 x 7.4-9.2 μ, No. 1872.

17. **Amanita rubescens** Fr.

A. asper Fr. (?)

PLATES 36, 37, 38 AND 67.

A very abundant, large or sometimes small plant that is solitary or gregarious in groves and woods, but is usually not very conspicuous on account of its being colored in harmony with its surroundings. Cap expanded, up to 11 cm. broad, faintly striate on margin, very variable in color, cinnamon-brown, pallid light cinnamon, sordid red-brown, pallid tan, buffy-brown, etc., or white, in variety *alba*, stained with reddish or brownish where rubbed, and in most cases covered by soft, flattish or pyramidal warts of the same color which are scattered over the surface, sometimes with beautiful regularity, sometimes only partially, or they may be almost or quite absent. They are quite distinct from the cap surface and easily removed. Surface between the warts viscid when moist. Flesh soft, white, slowly turning reddish when cut, up to 5 mm. thick at stem, very thin on margin; nearly odorless and tasteless.

Gills pure white, close, never branching, narrow, up to 5 mm. wide and nearly the same width throughout, just reaching the

stem by a point, veined at cap, margin fimbriate-eroded. When bruised they may or may not turn red.

Stem up to 20 cm. long, including the bulb, usually stout, up to 1.4 cm. thick at cap, enlarging gradually downward to the more or less bulbous base, or rarely with an abrupt bulb. Surface lightly flocculent-fibrous or smoothish, lighter than the cap usually, often with purplish tints, frequently stained with reddish and brownish when rubbed. Flesh firm outside, stuffed within, white and sometimes red when cut, never hollow. Bulb usually oval, smooth, with or without circles of small flat darker dots on its upper half.

Veil thin, ample, not friable, softly tomentose below, color of stem or yellowish or reddish or ashy buff, etc., hanging like a skirt and attached about 1 cm. from the cap, often torn in shreds and leaving no trace on the stem.

Spores (of No. 703) oval, 6.3-7 x 7.9-8.7 μ.

Edible, but it is very important to remember that the deadly *A. phalloides* has a very similar veil and bulb and often turns reddish after some time when bruised, so that none but the most typical forms of *A. rubescens* should be eaten. Unless one has considerable knowledge of the genus, it is best to let all the Amanitas alone.

Colored illustrations: Atkinson, Mushrooms, Plate 19, Fig. 2. Murrill, Mycologia 6: Plate 113, Fig. 1, 1914.

Not rarely there are met with in Chapel Hill small forms in this group that are difficult to refer with certainty. The cap is usually without warts and with light color, such as naples yellow, yellowish tan, light brown, gray-brown, etc. The stem is more or less enlarged below and usually with volva patches. The flesh of the cap may not change when cut, but the stem will usually turn brown when rubbed. Unless some yellow volva patches could be found I have referred these to *A. rubescens* without being at all sure that they were not *A. flavorubescens* or *A. spissa*. Such small forms are often very much like small plants of *A. phalloides*, but may be distinguished by absence of any volva margin on bulb, by the gills reaching the stem, and by the elliptic spores. In very doubtful cases I have relied on the spores.

167. Mixed woods, Battle's Park, September 21, 1908.

168. Open woods east of Gimghoul Lodge, September 11, 1908.

175. Mixed woods, Battle's Park, ground covered with leaves and other debris, September 14, 1910.

425. Growing on a gravelly soil at edge of meadows, September 21, 1908. Photo.

513. Woods near old school house, October 15, 1912.

Typical large plants. Spores short elliptic, 5.5-6.7 x 7.4-9 μ, most about 6.3 x 7.7 μ.

571. Near Howell's branch, October 7, 1912.

Cap 5.7 cm. wide, brownish tan with reddish-brown stains and lines, warts few, color of cap; margin slightly striate when mature. · Spores elliptical, 4.4 x 7.4 μ.

703. Woods near Battle's branch, June 20, 1913.

743. Woods on south side of meadow, Glenn Burnie Farm, September 12, 1913.

751. By path just west of athletic field, September 12, 1913.

This is a depauperate form that seems to be *A. rubescens*. Largest cap 4 cm. broad, 2.5 cm. in smallest. Color grayish brown, striate on margin. Scattered white volva patches on top. Veil thin, hanging as a skirt about 0.5 to 1 cm. from the top. Gills just reaching the stem. Stem bulbous, no trace of a volva on it, turns brown when bruised, 6.5 cm. high in largest plant. Spores elliptic, 4.5-5.5 x 7.4-8.2 μ.

752. Woods west of school house, September 13, 1913.

These two little plants are like above, but show more characters of *A. rubescens; i. e.*, stains of reddish on cap and stem, volva patches color of cap when young.

Both this collection and No. 751 are distinguished from *A. phalloides* by smooth bulb and stem and size and shape of spores.

1129. Pine grove at top of Lone Pine Hill, July 12, 1914.

Plants small, only 3-4 cm. wide. Spores elliptic, about 5.5 x 7.4 μ on average.

1778. At base of a pine stump and apparently coming from under it, woods north of barn, Glenn Burnie Farm, September 14, 1915.

This plant, 6 cm. high and 7 cm. broad, varies much from the typical *A. rubescens*. The pileus is "buffy brown" (Ridgeway) with only the very slightest red stains, white volva patches on top. Veil thin, part hanging compressed against the stem, part hanging from the edge of the pileus. The gills are white, crowded, narrow, just reaching the stem. Neither the cap nor the gills change color when bruised. Stem more typically *A. rubescens*, slightly enlarged at base, with reddish tint, especially toward the base, and red where bruised. This may be *A. spissa*.

1828. In path in woods near branch above Meeting of the Waters, September 19, 1915. Photo and drawing of spores.

Color near pallid or dull cinnamon, warts darker, soft, flattish, discrete and easily removed. Veil dusty-clay color below. Stem light purplish brown. Spores white, elliptic, smooth, 5-6.6 x 7.4-8.2 μ.

2144. Pine woods south of Mr. Tom Ellis' house, June 18, 1916.
Cap naples yellow with tint of green. Spores elliptic, most about 4.8 x 7.5 μ.

2148. Mrs. Kluttz's yard, by office, June 19, 1916.

Asheville, fairly common. Beardslee.
Flat Rock. Memminger.
Low district, damp woods. Curtis.

18. **Amanita rubescens** var. **alba** n. var.

PLATE 67.

We have in Chapel Hill a pure white, rather large plant with red stains when bruised and with the spores of *A. rubescens*. I have referred it to that species as variety *alba*. It is characterized as follows (description drawn from No. 2346):

Cap 9.5 cm. broad; surface white, viscid, no warts, staining reddish brown when bruised; margin faintly striate. Gills rather close, same width all length, only 3.5 mm. wide, white, but turning light ochraceous when bruised. Veil delicate, fragile and hanging from top of stem in collapsed strips. Stem fibrous inside, no central cylinder, gradually and slightly enlarged below, with light lines of deep red-brown color from the volva, also stains of red where bruised and flesh reddish below. Spores elliptic to pipshaped 4.5-5.5 x 7-8 μ.

2346. Woods by road to Scott's Hole, June 3, 1916.

2355. Battle's Grove, oaks, July 3, 1916.
Same characters as No. 2346 except that there are a few brownish-red warts on the cap, and there were distinct striations on the margin. Spores 4.5-5.2 x 6-7.5 μ.

19. **Amanita flavorubescens** Atk.

PLATES 39, 40 AND 67.

Cap up to 8 cm. broad, usually about 5-6 cm. Convex and then nearly flat and somewhat umbonate, dull or slightly shining, smooth except for the mustard yellow patches of the volva which are low, soft, scattered, and easily removed; margin slightly striate; color peculiar, the center being auburn, which shades to a lemon yellow on the margin, the two colors usually mixed and ex-

tending radially in streaks. In age the yellow usually fades somewhat, the brown predominating. Flesh thin, only about 2 mm. thick near the stem in large plants, white, but yellow just beneath the thin, easily removable cuticle, turning to a dull brownish red when broken. Fresh plants are odorless, but they very quickly decay with an unusually vile odor. When just beginning to decay the odor is, on the contrary, quite pleasant, being much like that of a seckel pear; tasteless.

Gills white, free, gradually broadening to near the margin, where they are about 4 mm. deep, rather close, and folding on each other like the pages of a book.

Stem slender, up to 12 cm. long, usually about 7-9 cm., and 6 mm. thick in center, gradually enlarging downward and sometimes slightly bulbous. Covered all over when fresh with flocculent particles, which are at first yellow, but soon turn brownish red at the lower end, the upper part usually remaining white or yellowish. There is a distinct central cylinder, about 1.7 mm. in diameter, that is lightly stuffed.

Veil thin and delicate, but persistent, mustard yellow below, creamy yellow above. The under side is lightly flocculent and fibrous like the stem. It breaks away from the cap and hangs as a rather small skirt on the stem about 6 to 10 mm. from the top. The color fades somewhat in age, but the margin remains yellow.

Spores (of No. 1158) white, oval to elliptic, and with an oil drop, 4.4-4.8 x 6.6-7.8 μ.

Edibility not known.

Colored illustration: Murrill, Mycologia 5: Plate 87, Figs. 4 and 7. 1913.

This species is most like *A. rubescens*, but is easily distinguished from it except in depauperate forms by the color of the cap, the yellow volva and veil, the stem flocculence, and the distinct central cylinder in the stem. The latter plant was growing abundantly in the same swamp with this, and sometimes very near it, and they were conspicuously distinct, with no intermediate forms.

1158. Swamp of New Hope Creek, above and below Durham Road crossing, July 18, 1914. Photo.

2082. Swamp of New Hope Creek, 100 yards below bridge on Chapel Hill-Durham Road, June 13, 1916.

2167. Mixed woods between Sphagnum bed and branch, June 20, 1916.
Two small plants, cap 3.5 cm. in diameter, of a light isabella color, darker in the center; and with a small yellowish volval collar near the base. Spores short-elliptic, 4.8-7.4 x 7.4-9.2 μ.

2226. In several places on the bank of New Hope Creek from the Chapel Hill-Durham bridge on the lower road, June 24, 1916.

Asheville, occasional. Beardslee.

19*a*. **Amanita flavorubescens** Atk. A form.

PLATES 41 AND 42.

Cap 3.7-10 cm. wide, distinctly gibbous-umbonate, viscid when wet, the margin plane and slightly striate, surface mostly smooth, but here and there granular warted like a frog, a few friable, lemon-yellow volva patches or none; color not at all that of the typical form, center pale buffy vinaceous or a deeper vinaceous (russet vinaceous—Ridgeway), fading to a pale fleshy straw on the margin. Flesh about 5 mm. thick near the stem, white but changing rather quickly to vinaceous when cut, tasteless and odorless.

Gills rather crowded, 7-9 mm. wide, rounded at stem and scarcely reaching it, broadest a little beyond the middle, in all these plants except the smallest one curiously branched and anastomosing in a dedalioid manner near the margin; color pure white, vinaceous when bruised.

Veil thin, membranous, hanging as a neat and perfect skirt about 1-2.5 cm. from the cap, pure white or the margin yellowish.

Stem 5-9 cm. long, tapering upward, 5-12 mm. thick at top, gradually swollen below and subbulbous, surface slightly fibrous below the veil, smooth above, white, but soon stained with brownish vinaceous; firm, flesh white, vinaceous when cut, a distinct central cylinder about 3 mm. in diameter that is permanently stuffed.

Volva lemon yellow, friable and remaining almost entirely in broken particles in the ground, just as in *A. Frostiana*, but even more soft and fragile.

Spores pure white, smooth, variable, subspherical to elliptic, 4.8-5.2 x 7.5-9 μ. Exactly as in the typical plant.

2133. Clay soil in open place in Battle's Grove (Oaks), June 17, 1916. Photo.

20. **Amanita Frostiana** Pk.

A. flavoconia Atk. *A. muscaria minor* Pk.
A. elongata Pk.

PLATES 43, 44 AND 67.

The Chapel Hill form described below is the typical *A. flavoconia* of Atkinson.

Cap up to 8.5 cm. in diameter, convex at first, then nearly flat and sometimes even with upturned edges; surface slightly shining and somewhat viscid when young, dull and dry when old; color orange-yellow, becoming paler and browner with age, and finally when quite old almost leather color. When quite young there are small scattered patches of the friable yellow volva on the cap, but these rarely remain present at maturity. The margin is not striate or very faintly so in some specimens (in the typical *A. Frostiana* the cap is said to be striate on the margin). Flesh very thin, only about 4 mm. thick at edge of stem and only 1.5 mm. thick half way to edge, white except just below the surface, where it is yellow.

Gills white, straight, rather close and deepest near the middle. They barely reach the stem and as the plant expands and the top of the stem widens they seem to stop some distance from it, but extend to it by a little line. As they get older the gills become light yellow with deeper yellow stains.

Veil very thin, but not friable, either remaining on the stem as a distinct annulus, about 1.5-2 cm. from the top, or hanging to the margin of the cap. Two of the five mature specimens of collection No. 698 had the veil attached to the margin of the cap and hanging in scattered tatters, while three had it on the stem as a distinct skirt. The veil is yellow on under side and white on top, but fades when old to white all over. The under side of the veil is slightly yellow flocculent, as is the stem below it.

Stem up to 13 cm. in length, usually about 6-7 cm., tapering upward from the distinct but not large bulb. When young and fresh it is yellow below the veil and white above it, in this way resembling the color of the two sides of the veil. The color above the veil is due to the extension upward of the same tissue of which the veil is composed, and, as shown by the cracks, the stem surface below this superficial tissue is yellow, as it is below the veil. The stem is solid and its flesh is white, except immediately below the surface, where it is yellow. The bulb tapers gradually both above and below, and often shows no trace of the friable yellow volva, which remains attached in deep yellow fragments to the adjoining earth. Sometimes there are visible lines of orange near the top of the bulb, marking the volva. As said above, the upper part of the volva remains on the cap in small friable patches which fall away by maturity. The base of the stem above the volva attachment is furnished with deep yellow flocculence, which extends more faintly as far as the veil.

Spores short elliptic, some with a large oil drop, some granular from the same plant (the granular ones being younger probably). Atkinson says (of *A. flavoconia*) that the spores are "quite constantly granular." They are (in No. 1112) 4-5.5 x 5.9-7.8 μ, most about 4.8 x 6.6 μ.

Amanita Frostiana has been considered poisonous by some, but probably only because of its supposed close resemblance to *A. muscaria*. Ford has found it to be perfectly harmless (Jour. Phar. and Exp. Ther. **1**: 286. 1909).

Colored illustrations: McIlvaine, One Thousand Am. Fungi, Plate 6, Fig. 5; Murrill, Mycologia **5**: Plate 87, Fig. 5, 1913.

Murrill (N. Am. Flora **10**: 74. 1914) considers this species *A. Frostiana*, the same as *A. flavoconia*, but both Atkinson and Peck consider them different. Peck (Bull. N. Y. St. Mus. **67**: 21. 1903) says of the latter: "Closely resembling *A. Frostiana*, Peck, in size and color, but distinguishable by the even margin of the pileus, the floccose edge of the lamellæ, and the fragile character of the volva, which easily separates from the slightly bulbous base and adheres to the soil that surrounds it. Both it and the annulus are a beau-

tiful chrome-yellow color." It will be noted, however, that our plants which are otherwise typical *A. flavoconia* are sometimes slightly striate on the margin (see photo of No. 1112), and the soft volva patches may form a distinct ridge on the bulb. Considering the very slight differences and the great variability of the Amanitas I hardly think it desirable to treat the two forms as distinct species. Peck says that *A. Frostiana* at times is pale yellow and the stem and annulus white, and gives this form the variety name *pallidipes* (N. Y. State Mus. Rep. **53**: 855. 1900).

A. elongata Pk. (N. Y. St. Mus. Rep. **131**: 33. 1909) is almost certainly this species, in which there is a tendency for the stem to be long and the cap small. I have examined the type and the spores agree well, being 5.5-5.9 x 7.5-8 μ.

In Chapel Hill this fine species is most common in summer. It occurs in all kinds of places; in lawns, pastures, upland woods and ravines, and in both clay and sandy soil. In climbing Mt. Mitchell in August, 1913, I found this species to be not uncommon in the damp, cool, mossy balsam groves of the high flanks and summits. It was the only Amanita seen that day at so high an altitude.

In placing this species near *A. muscaria* it seems to me that others have been mistaken. It is, I think, nearest to *A. flavorubescens*.

172. In woods east of Schizomeris pool, October 1, 1909.
698. In open campus near center monument, June 19, 1913.
705. In woods near Battle's branch, June 20, 1913. Spores 4.8-5.2 x 5.9-7.5 μ.
758. In moss near Battle's Brook, September 14, 1913. Photo.
805. Near Battle's branch just east of Dr. Battle's house, September 26, 1913.
862. In woods south of graded school; October 2, 1913.
1112. Oak woods south of Mrs. Gore's house, July 10, 1914. Photo.
1126. Woods near King's Mill, July 12, 1914.
1167. Deep rich woods at Lone Pine Spring, July 21, 1914.
1431. Woods northwest of Brockwell's Spring, Battle's Park, October 27, 1914.
1558. Wooded hillside near branch west of Meeting of the Waters, June 19, 1915.
1822. Woods by Howell's branch, September 15, 1915. Photo.

One small plant. Cap 3.3 cm. broad, center with thick, flattish yellow warts, margin not striate or faintly so in places. Color deep reddish orange in center, much lighter ochraceous yellow on margin. Gills light ashy yellow, close, 4 mm. wide, margin eroded. Stem 3.3 cm. long, 4 mm. thick, a small, smooth, oval bulb, finely flocculent-pubescent and orange below veil and over most of bulb, no friable patches of volva adhering,

light cream and pruinose above. Veil yellow pubescent below, creamy above, forming a medium skirt on the stem. Spores smooth, oval-elliptic, 5.2 x 7.5 μ.

2098. Battle's Park, near branch, June 14, 1916.

Blowing Rock. Atkinson.
Asheville, not rare. Beardslee.
Flat Rock. Memminger.

21. **Amanita solitaria** Bull.

A. monticulosa B. and C.

PLATES 45, 46, 47 AND 68.

A large, conspicuous plant growing singly in open woods.

Cap up to 14 cm. wide, pure white or old ivory and silky shining, viscid when moist, adorned in center with large, pointed, pyramidal warts up to 4 mm. high, which decrease in size toward margin and merge at very margin into low, finer flocculence, which is not at all friable and does not come off freely. The warts may be more or less washed off in wet weather, but when dry they are firmly attached. The flesh is pure white, solid, firm and without the slightest odor of chlorine in our southern form at least.

Gills white with a tint of flesh color when fresh, quickly bent upward at stem and just missing it. They are very deep, 1.2 cm. not far from the margin (where they are deepest).

The veil is very interesting. It is not at all friable, but is fibrous, ample, and compound in the sense that in addition to the upper strong layer, which is attached at the very top of the stem, there are strong and abundant fibers and sheets that extend from the lower surface of the veil to the stem for almost its whole length. As the stem lengthens these fibers are pulled loose, leaving lines and wisps until about 3 to 5 cm. from the top, when they become more dense and there form a series of conspicuous, cottony, partial rings and wisps, which are strong and persistent, but may collapse against the stem. In tearing from the cap the veil often leaves a tattered fringe hanging from the cap margin, and rarely the veil may become almost all torn loose from the stem.

Stem up to about 11 cm. long above the bulb and 1.5 cm. thick in center, almost equal, ending below in a large, but not abrupt,

bulb that is usually much extended below into a rooting base. The stem surface is white and is usually marked with wisps and fibers of the veil over its upper half or more, the lower part often with slivers, cracks and ridges, which are larger downward and nearly always mark the upper part of the bulb. A distinctive character usually exhibited by the stem is the well-marked central cylinder about 7 mm. in diameter which is stuffed permanently with rather fine, dense, white cotton that is always whiter than the outer part and *does not water soak* as the central cylinder does in *A. abrupta.* This stuffed white cylinder is not always clearly marked. Sometimes it cannot be made out at all, but the soft homogeneous cottony center, whether or not it is sharply outlined, is quite different from the coarse, fibrous, often lacunose, center of *A. strobiliformis, A. chlorinosma* or *A. excelsa.* It is much smaller and more densely stuffed than in *A. spreta,* where the very fragile cottony stuffing collapses on being exposed.

Spores of No. 814 elliptic, 7.4-9.2 x 11.1-13 μ.

Edible. Some European authors say that this species is poisonous, others that it is edible, but all Americans who have tried it pronounce it edible and good. Ford has found that the raw plant contains a poison which acted upon blood corpuscles. It is probably destroyed on cooking (Jour. Phar. and Exp. Ther. **1**: 280. 1909).

Colored illustration: Murrill, Mycologia **8**, No. 5, Plate 190, Fig. 1, 1916. (?) This does not look like our southern form of this species.

A. solitaria varies in the following points:

1. The cap, especially in rainy weather, may crack up into rounded slivers in center and most of the warts may be washed off. Also there may be shades of light soiled brown or even ash color in center, and much darker forms are said to occur in the North.

2. The gills may be lacerated and cut up into narrow plates and teeth over much of the surface like the pore surface of Lenzites at times. Three specimens of No. 823 show this well.

3. The abundant lower fibers of the veil mark the stem differently in each case. Sometimes there is almost a second perfect ring several cm. below the more ample upper one. Sometimes

there are scattered partial wisps and ridges all over the stem; sometimes these fibers tear away so evenly as to leave the upper part of the stems almost evenly fibrillose.

4. The dense stuffing of the central cylinder, which is usually present, may occasionally become separated from the surrounding flesh so that it can be lifted out as a plug.

5. The bulb may be stained with brown or reddish brown.

6. Quite small, depauperate forms are occasionally found.

While our southern plant has no odor of chlorine, both McIlvaine and Hard mention an odor of chloride of lime. Neither Peck nor Atkinson speak of an odor, but Fries says the taste and odor are "fatuus," whatever that may mean. The species has so often been confused in America with forms of the chlorinosma group that mistakes in regard to the odor might easily have crept in.

Amanita solitaria may be most easily distinguished by the veil, which is unlike any of our other species except *A. abrupta*. The veil of *A. strobiliformis* is not fibrous below, but softly tomentose flocculent, and is not compound, while that of *A. chlorinosma* is farinose, very fragile and quickly falls off.

I have examined the type plants of *A. monticulosa* in the Curtis herbarium and find them to be this. The spores are identical.

171. Woods on road to Scott's Hole.
177. Battle's Park, open mixed woods, October 14, 1910.
304. Battle's Park, open mixed woods, September 28, 1910.
450. Woods south of Dr. Battle's, September 27, 1912. Photo.
453. Woods east of campus, south of Dr. Battle's, September 27, 1912.
475. Woods east of school house, October 2, 1912. Two photos.
651. Dry woods, Battle's Park, September 19, 1910.
652. Battle's Park, open mixed woods, October 14, 1910.
814. Woods back of Dr. Howe's, September 21, 1913. Spores white, elliptic, 6.6-7.7 x 11-13.7 μ.
823. Battle's Park, September, 1913. Gills cut and toothed; spores white, elliptic, with lateral mucro at one end, one large oil drop; in one plant, 6.5-11 x 11-14.8 μ, in another 7.4-11 x 11-13 μ.
987. In woods east of road to Purefoy's Mill, October 15, 1913.
1113. Woods south of Mrs. Gore's house, July 10, 1914. Photo.
1122. Sandy soil near Scott's Hole, July 12, 1914. Photo. This was a very small, depauperate plant only 4 cm. wide by 6 cm. high, but it was typical in characters in every way. Spores elliptic, smooth, 6-9 x 9-12.6 μ.

2358. By road to Scott's Hole, July 3, 1916.

Blowing Rock. Atkinson.
Common, sandy woods (as *A. monticulosa*). Curtis.

22. **Amanita abrupta** Pk.

PLATES 48, 49 AND 68.

This elegant and well-marked species has apparently been reported only twice, and that practically without notes, since its first description by Peck from plants collected by Underwood at Auburn, Ala. E. M. Williams lists it from Washington, D. C., under date of July 20-28, 1899, adding, "Only a few specimens found" (Asa Gray Bull. 7: 79. 1899); and McIlvaine (One Thousand Am. Fungi, p. 24) reports it from New Jersey and Pennsylvania, July to September, and adds, "This species is edible and quite equal in quality to *A. rubescens.* Great care should be exercised in distinguishing it." Peck's description, while not lengthy, is clear, and agrees well with our Chapel Hill plants, but as the species has been so rarely seen it is listed by Murrill as doubtful (N. Am. Flora **10**: 76. 1914), who adds, rightly, that it is near *A. solitaria.* As the species is rather plentiful with us, I have been able to compare it carefully with *A. solitaria,* and remove all doubt, I think, as to its specific distinction.

The plant is an exceptionally handsome one, pure white, firm, and durable, slender, graceful stem on a large abrupt bulb. It is of medium size, growing in mixed woods, from July to October.

Pileus pure white or center straw colored, 4-8 cm. (usually about 5-6 cm.) broad, adorned with rather small sharp warts which are often arranged with beautiful regularity in concentric rings, or may be washed away to a greater or less degree. Between them the cap is smooth and shining. Margin faintly or not at all striate when mature. Flesh thin, white, firm, odorless.

Gills white, not crowded, barely free, and connected with the stem by a line, about 6-7 mm. deep in center.

Veil delicate, but compound and persistent, attached about 0.5 cm. from the top and dropping down like a skirt, or tearing away from the stem and hanging to the gills. The under surface

is attached to the stem for a distance of almost 2 cm. by fibers in expanding, just as in *A. solitaria*.

Stem slender, 7-12 cm. high, including the bulb, 5-12 mm. thick in center, tapering upward, surface white, more or less flocculent-fibrous, flesh solid, firm, with a very distinct central cylinder about 0.5 cm. in diameter, which is firmly stuffed with a kind of pith which immediately becomes water soaked when the cut stem is dipped in water, thus sharply outlining itself from the surrounding material. Bulb large to very large and usually quite abrupt, rounded below and not rooting, its surface quite smooth or somewhat ridged and cracked. The volva is represented below, if at all, only by a low ridge where the stem joins the bulb.

Spores (of No. 757) elliptic, or in some plants mostly spherical, 6-7.4 x 8.2-11 μ.

This is said to be edible by McIlvaine, but it should not be eaten without cautious experimenting.

A. abrupta is nearest *A. solitaria*, but can be easily distinguished by much smoother, more abrupt, and proportionally larger bulb, smaller stem, smaller size, and bibulous central cylinder. In many cases this cylinder does not show to the eye when first cut, but if dipped in water it appears immediately. This peculiarity is constant and will immediately distinguish this species from any other. *A. solitaria* often has a distinct central cylinder permanently stuffed with cotton, but it does not become water soaked when wet. It resembles *A. solitaria* most in the multiple veil, the membranous upper part of which is attached almost at top of stem, and in the firm pyramidal warts on the cap.

153. Battle's Park, near east gate, September 14, 1910.

451. Battle's Park by path to Piney Prospect, September 27, 1912. Photo.

545. Battle's Park, near branch, October 10, 1912. Photo.

757. Woods east of graded school, September 13, 1913. Cap 4.5 cm. broad. Stem, including bulb, 6 cm. long.

760. Battle's Park, September 14, 1913. Two photos. Spores mostly spherical, 7.4-8.3 μ, a few short-elliptic, 5.9-7.4 x 6.6-9 μ. Many plants were seen to-day.

809. Battle's Park, behind Dr. Howe's house, September 21, 1913. Spores short-elliptic, 6.5-7.4 x 7.4-9.2 μ.

1191. Right by branch about ¼ mile above Meeting of the Waters, July 22, 1914. Spores oval with mucro, granular, some also with oil drop, 3.1-5.9 x 6.8-8.5 μ.
1749. Battle's Park, September 12, 1915.
2307. Woods, top of Lone Pine Hill, June 29, 1916.

Asheville, in pine woods. Beardslee.
Flat Rock. Memminger.

23. **Amanita strobiliformis** Vitt.

A. Ravenelii B. and C. *A. radicata* Pk.
A. muscaria var. *major* Pk.

PLATES 50, 51, 52, 53 AND 68.

This is a heavy species with a massive base, and is second only to *A. chlorinosma* in size. The plants may grow scattered or in cespitose groups with their bases connected underground.

In No. 849 the plants were in three groups in an area of a couple of yards. The members of each group were connected from their large radicating bases by thick plates and masses of tissue, the parts below ground being of enormously greater mass and weight than any of our other species. The photos taken of this collection show the structure clearly, but do not show the full extent of the underground tissue.

Cap convex or nearly flat, up to 16 cm. broad (no doubt the largest would have grown broader, had it not been collected when half expanded and allowed to expand in the laboratory), typically covered all over with inherent, flat areolations and patches, more or less concentrically arranged and pinched up in their centers to pointed brown warts, which are largest in center of cap, where they reach a height of 2-2.5 mm., and reduced to nothing on margin. These warts are tightly adherent, and are largest in the button stage. In some cases, as in Nos. 855 and 1097, the warts are reduced to almost nothing, the cap surface being cracked very evenly into small inherent patches. At other times the cap surface may be deeply cracked in large, shingle-like scales (see photo of No. 856). The color of the cap is a light brownish cream, the warts darker. Flesh very firm and dense, about color of ivory, 1.5 cm. deep above margin of stem; a strong smell of chlorine.

Gills a deep cream color, moderately close, scarcely touching stem, deepest in middle, where they are 8 mm. wide.

Veil with a thick marginal roll as in *A. solitaria, A. Atkinsoniana* and *A. abrupta,* not friable as in *A. chlorinosma,* but densely flocculent below as in *A. magnivelaris.* This flocculence is easily rubbed off, but is not composed of minute mealy particles as in *A. chlorinosma.* The veil is attached at the very top of the stem and expanding usually breaks first from the stem, splits into segments and hangs from the cap margin. Its under surface is connected by its flocculence to the upper part of the stem for a distance of about 4 cm. and in tearing away that part of the stem is left covered with a soft dense flocculence, the largest fibers being at the lower extremity. This flocculence is not in the form of large flakes and wisps as in *A. solitaria.* The veil is exactly intermediate in structure and behavior between *A. chlorinosma* and *A. solitaria.*

The stem is very hard and solid all through, its surface covered with a dull, slightly fibrous and scaly layer which cracks and exposes the shining smooth surface below. The stem expands into a very massive and deeply rooting bulb which has no friable meal on the surface, and may be nearly smooth or more commonly covered with concentric plates or shingles pointing upward and perhaps bending outward at the tip. These may be very wide, long, and conspicuous or nearly absent. The appearance of the young button at the top of the massive bulb which projects above the ground is characteristic.

Spores white, short-elliptic or at times spherical, 5.5-7.4 x 7.4-9.2 μ.

Edible. *A. radicata,* a form of this, is said by Ford to contain a small amount of a heat-resisting poison that he thinks similar to that found in *A. phalloides* (Jour. Phar. and Exp. Ther. **1**: 283. 1909). However, *Amanita strobiliformis* has been eaten repeatedly by many people and has never hurt any one. It is pronounced among the best by McIlvaine.

These plants here described as *A. strobiliformis* vary in size and shape of bulb, surface of bulb quite smooth to coarsely slivered and shingled. Cap covered with only low inherent slightly pinched

up areas or with high sharp narrow warts in center or with whole surface cracked into deep imbricated scales. The species is closely related to *A. chlorinosma* and they vary toward each other in all of their characters. The former has usually a more massive base and much larger warts than the latter, but the base of *A. chlorinosma* may be very large (see photo of No. 464) and the warts of *strobiliformis* may be almost absent. The most reliable distinction that I can find is the presence of friable meal on *A. chlorinosma* and its absence in *A. strobiliformis,* but even this is not quite constant. In typical plants the veil is less fragile in the latter and is softly tomentose and not friable mealy below. Closely intergrading forms are not common, but every now and then we find plants, as in collection No. 859 (which see under *A. chlorinosma*), so nearly intermediate as to make practically impossible any absolute separation of the two species. As typical plants of the two species are exceedingly different, and much more common than the intermediates I think it best to retain the two species named and acknowledge the intermediates. Where intermediates are more common than the extremes, as in Forms A and B of *chlorinosma,* I have thought best not to make new species.

The *strobiliformis-chlorinosma* group may be distinguished from *A. solitaria* by the very different character of the veil in the two groups, the much larger spores of the latter and the absence in it of the chlorine smell. The veil in *A. solitaria* is strong, compound, and persistent and is not attached at the very top of the stem.

849. In oak grove in front of Dr. Battle's house, September 26, 1913. Five photos. Spores 5.5-6.7 x 7.5-8.2 μ.

855. One plant, dry woods south of Dr. Battle's. Two photos.

This plant has a large, smooth bulb above ground, tapering below to a short root. Cap covered all over with the inherent scaly cuticle which was pinched up only into very small warts even in center. No granular meal. Veil as in No. 849, as were all other points. Spores white, spherical or very short elliptic, 5.5-7.4 x 7.4-9.2 μ.

856. Two plants, dry woods, south of Dr. Battle's, September 29, 1913.

One of these had a long deep-rooting bulb, the other a short, abrupt, shallow-rooting bulb. The first had the cap deeply lacerate scaly, the other cap was as described for No. 849. Spores white, spherical or very short elliptic, 6.5-8.3 μ in diameter.

878. One large plant, in dry woods west side of road to Purefoy's Mill. October 4, 1913. Photo.

In this interesting specimen the marginal part of the veil had remained sticking to the stem when the cap expanded and formed a radially split ring about 6 cm. below the cap. Above this ring the stem showed the characteristic dense, soft and uniform pubescence. That part of the veil from the ring to the very top of the stem has fallen away and disappeared.

911. Oak grove near Dr. Battle's front gate, October 14, 1913. Photo.

1079. Battle's Park, about half way between cemetery and Battle's branch, July 5, 1914.

Asheville. Beardslee.
Blowing Rock. Atkinson.

24. **Amanita chlorinosma** Pk.

A. candida Pk.
A. polypyramis B. and C.
Amanitopsis pulverulenta Pk.
A. umbella Paulet (in sense of Quélet).
A. lenticularis Fr. (?)

PLATES 54, 55, 56 AND 68.

This is our most protean species, varying greatly in size, color of all parts, even the spores, size of bulb and depth of root, and all extremes are connected with one another by intermediate forms. The large, usually pure white, form reaches a greater size than any of our other Agarics. At the other extreme is its close relative, the small gray plant called *A. cinereconia* by Atkinson. Innumerable gradations which are more abundant than the extremes make it impossible to define species among these forms, but starting from the large white plant as a mean, there are three distinct lines of variation, and in order to reduce the situation to some order I shall call the large white plant the typical *chlorinosma,* and the three variant groups as two forms and one variety of it. One of these forms is ashy olive or ashy umber with a strong tendency to olive spores. This I shall call Form A. The other form is salmon or strawberry in color and is called Form B. Well-marked plants of either form are nearly always smaller than the type. I know of no published American reference to olive gills and spores in this group, but in the Curtis herbarium there is a plant labeled "*Ag. lenticularis* Fr. (?), Hillsboro, N. C., August-September, 1864," to which are at-

tached the following notes: "Cap and stipe wholly covered with a farinose deposit of a pale yellowish-ash color. Gills same color, becoming olive. . . ." This is our *A. chlorinosma* Form A. (Hillsboro is only 13 miles from Chapel Hill.) Beardslee has also noticed the olive gills and spores in Asheville plants. The typical *A. chlorinosma* may be described as follows:

Plant usually chalk-white, solitary or gregarious, and attaining a height of 13 in. with cap 12 in. in diameter. Cap typically white, varying to pinkish brown, usually convex, sometimes nearly plane, margin not striate, covered with a soft friable meal which may extend over the entire cap or may gradually merge toward the center into small, slender, thick set, soft spines or into flat scales. The granular meal is easily removable, but the spines and scales are not. Flesh white and rather soft with a strong odor of chloride of lime.

Gills pallid white (slightly ashy white), not creamy, deepest near the middle, where they are 1.5 cm. wide, just reaching the stem.

Stem white, usually stout and rather long, typically expanded below into a large to very large or rarely reduced bulb, which is usually even or very rarely ridged or cracked, and may or may not be deeply rooted; surface of stem and bulb more or less completely covered with a coarse mealy powder like the cap margin. Flesh solid and fibrous all through.

Veil ample, but very fragile and friable, covered on the lower side with large and small particles of friable meal, the upper side smooth. It is attached to the very tip of the stem, but little or none is left on the plant at maturity, the bulk of it being cast in small fragments on the ground. No trace of a volva is distinguishable except the meal on the bulb, and this is sometimes absent.

Spores (of No. 431) elliptic, slightly larger at one end than at the other, a small eccentric mucro on the large end; 4.8-6.3 x 8.5-10 μ.

Said to be edible by McIlvaine and Mrs. I. M. Jervey. Though said by Ford to contain a small amount of a poison like that in *A. phalloides* (Jour. Phar. and Exp. Ther. 1: 283. 1909).

The only illustrations I can find of *A. chlorinosma* are by Williams in Asa Gray Bulletin 7: Plate 6, 1899; by Hard in The Mushroom, Fig. 22 (as *A. strobiliformis*), which are good and easily recognized as our typical plant; by McIlvaine, Plate 6, Fig. 1, which is less good. On Long Island I have seen the typical *A. chlorinosma,* agreeing well with our southern plant.

I have used Peck's name for this plant because there can be no doubt about his description applying to our large white form, while there is some doubt about other names.

The description of *A. polypyramis* B. and C. (Ann. Mag. Nat. Hist. 32: 417. 1853) might allow it to be either *A. strobiliformis* or *A. chlorinosma,* but after seeing the two plants so named in the Curtis herbarium, I have little doubt that it is a form of the latter, though not the typical large farinose plant. This latter was called by Curtis *A. excelsa* Fr., as shown by a plant in his herbarium, and was so listed in his catalogue of North Carolina plants. This was, of course, a mistake. He also listed forms of *A. chlorinosma* as *A. lenticularis* Fr., with a question as noted above. *A. candida* Pk. (Bull. T. B. C. 24: 137. 1897) is a form of this, and the plants in Peck's collection under this name are just like ours. *Amanitopsis pulverulent* Pk., while small, is also almost certainly a form of *Amanita chlorinosma,* the spores (4.8-5.2 x 8.5 μ, my measurements of the type) agreeing well in shape and size. But *Amanita prairiicola* Peck (Bull. T. B. C. 24: 138. 1897), which is in the *solitaria* group, is not, nor is *A. multisquamosa* Pk. (Ann. Rep. N. Y. St. Mus. 53: 840. 1900), which is very different, and is, I think, *A. junquillea.* Atkinson refers a plant much like *A. chlorinosma* to *A. virosa* in his Studies of American Fungi, p. 61.

A. chlorinosma seems near *A. echinocephala* Vitt., as figured by Paulet (Traite Champ., Plate 163, as *Hypophyllum tricuspidatum)* and by Quélet in Champ. du Jura et des Vosges, Plate 1, as *A. strobiliformis;* and Vittadini in his original description of *A. echinocephala* speaks of the gills being white and becoming green. He says "lamellæ ventricosæ, ex albido-virescens," and again, "dicolor bianco-pallido, virgente al verdognalo" (Descr. Funghi Mang. 346, 1835). But Vittadini described the veil as persistent, distant, not

at all fragile, and he says eaten in small amount it causes vomiting, convulsions, diarrhœa and similar symptoms. All of these characters are different from our plant.

In his monograph on Amanita, Quélet lists *A. umbella* Paulet, and says the spores are green, the odor strong, and that the lamellæ become greenish; and his description in other ways fits our plant pretty well. But Boudier does not think *A. umbella* Paulet distinct from *A. solitaria,* in which he is probably wrong. It seems probable also that *A. lenticularis* Fr. is nearly the same as the greenish form of this species (see below).

147. Battle's Park, near bath house, October 2, 1909.
149. West of Chapel Hill, October, 1909.
150. Woods south of campus, September 15, 1909.
151. Battle's Park, near Indian Spring, October 13, 1909.
176. Behind dissecting hall, September 15, 1910.
309. Woods, Battle's Park, September 29, 1911. Color very light, a slight tint of grayish salmon. This is intermediate between all the forms.
431. Battle's Park, near branch back of Dr. Wilson's, September 26, 1912. Spores elliptic, granular, 4.8-6.3 x 8.5-10 μ.
435. Battle's Park, south of Dr. Battle's, September 25, 1912. Two photos. Largest plant elliptic, 9 x 12 in., color of all good-sized plants was pinkish brown, darkest in center and shading to almost white on edge, surface mealy as well as tuberculate.
464. East of Hillsboro Road, across creek, September 29, 1912. Photo.
540. Battle's Park, back of Dr. Wheeler's, October 10, 1912. Photo.
612. Woods east of campus, October 14, 1912. Photo. Spores elliptic, 7.4 x 11 μ.
792. Battle's Park, September 19, 1913. Spores elliptic, with lateral mucro at one end. 5.5-7.4 x 9.2-11 μ. Plant intermediate between typical white form and olive-buff variety.
799. Battle's Park, back of Dr. Herty's, September 21, 1913. Spores elliptic, 5.5-7.4 x 9.2-11 μ.
858. Dry woods southeast of Dr. Battle's, September 29, 1913.

This collection of two plants was nearly intermediate between *A. chlorinosma* and *A. strobiliformis.* The two plants were alike, one 16 cm. and one 21 cm. broad. The cap was exactly like typical *A. chlorinosma* except that the color was more creamy than usual in the type.

Veil delicately fibrous-flocculent below, hung about 0.5 cm. from the cap, not friable, and not very fragile. Its delicate fibers on under side ran into stem and left a fine flocculence when broken, thus resembling that of *A. strobiliformis.*

Gills ashy gray with tint of flesh in deep view, reaching stem, 4.5 mm.

deep in center; stem flocculent above and light scaly fibrous in middle, the base ending in a small oval white bulb with small scaly warts on upper half and extending a little way up the stem.

Spores cream color, spherical to short elliptic in one plant 6.5-8 x 7.4-9.2 μ, in the other 6.5-8.3 x 7.4-10 μ.

860. Dry woods, Battle's Park, September 29, 1913. Spores white with a touch of cream, elliptic, in one plant they were 5.5-8.3 x 8.3-14 μ; in another, 6.5-8.3 x 7.4-14 μ; in another, 5.5-7.4 x 8.3-13 μ; in another, 6.5-7.4 x 9.2-12 μ. These were all typical, pure white large plants.

1826. Upland woods, Battle's Park, September 18, 1915. Photo.

This plant had a perfectly *smooth, shining* cap, no trace of meal or warts, although it had not rained for ten days. Stem bulbous, bulb and stem covered with mealy stuff, of a slightly greenish tint on bulb. Usual chlorine smell. Gills dusty cream.

Blowing Rock. Atkinson.
Asheville. Beardslee.
Montreat, July 6, 1915. Coker.

24a. **Amanita chlorinosma** Form A. Ashy Olive-buff.

A. umbella Paulet (?) *A. lenticularis* Fr. (?)

PLATES 1, 57 AND 68.

This is the smallest and most extreme form of *A. chlorinosma*, and is distinguished by its usually smaller size, its peculiar ashy-olive or ashy-buff color with deep blue-green stains on the bulb (as a rule), and the color of the spores which are not white but olive buff or ashy buff (usually), or cream colored (occasionally). The bulb is usually even and covered with meal, but is sometimes marked with small scales. Extremes of this form approach near *A. cinereconia* of Atkinson, but in that species the cap is distinctly umber, and the spores are white.

In his catalogue Curtis lists *A. lenticularis* Fr. with a question mark. I have examined the plant so labeled in his herbarium and find it to be this form of *A. chlorinosma*.

A complete series of variations connect the extremes with the typical *A. chlorinosma*. I give below notes on several of the collections.

Collection No. 308 was pallid ashy olive in color all over, including the gills; bulb with a very slender root; pyramidal warts

mixed with soft meal on cap; greenish stains on bulb; gills lavender tinted in certain angles. Spores cream colored, 6-7.5 x 9-11 μ.

No. 314 was like No. 308 except that the remains of the volva were washed from the center of the cap by rains; the surface being frosty looking on the marginal half and smooth in the center. Color of cap nearly white, but stem a pallid ashy gray, farinose and green tinted below as in No. 308; gills exactly as in No. 308; stem rooting very deeply (11 cm.), and slender; no sign of volva on bulb; veil entirely gone; spores ashy gray, elliptic, 8 x 11 μ on average.

No. 460 was very near *A. cinereconia.* Cap. 5 cm. broad, convex, smooth, not striate, covered like the veil and stem with a soft friable meal that is light brownish gray in color. When this is rubbed off it exposes the very smooth and shining cap surface, which is about the same color. Gills not crowded, close, but free from stem, color of cap. Veil very fragile, soft-friable below, attached at very top of stem, breaking away from the stem, where it leaves a line at top and hanging usually in large torn fragments to the margin of the cap, falling away when disturbed just as in the typical form. Stem 9 cm. long above ground, 9 mm. thick in center, tapering upward, extending into the ground at least 15 mm., covered above by soft meal which in this connection had disappeared in lower part. At ground and a little above the stem was stained with greenish-black lines and dots, which, while distinct, were not conspicuous, no bulb, but largest at the ground. A distinct smell of chloride of lime just as in *A. chlorinosma*, but not so strong.

September 19, 1913, a very perfect specimen was brought in (No. 791, apparently lost). Cap 7.5 cm. in diameter; stem and bulb 12 cm. long; color of cap and stem an ashy buff; gills superficially this color, but much darker in bulk; bulb stained with green just as in No. 308; odor of old ham; cap, stem, and bulb covered with friable, easily removed meal. Spores *olive buff*, short elliptic, 6.5-9.2 x 8.3-11 μ. Veil very fragile and cast to the ground. Another plant (No. 729, entered by number under type) was exactly intermediate between the above and typical *A. chlorinosma.* Its cap

was a light creamy tan in center, white on margin; gills exactly intermediate between white and the color above; that is, they are grayish cream; stem and bulb covered with small scales that are not friable; spores cream color, elliptic, 5.5-7.4 x 9.2-11 μ. In the scaly bulb this also approaches a little toward *A. strobiliformis*, as does also Nos. 858 and 1320.

308. In woods south of "The Rocks," September 27, 1911.
351. Woods under pines near Howell's Spring, October 11, 1911. Ash gray in color; stem greenish below; gills light cinnamon color with a tint of lavender at certain angles. Spores 4.8-7.4 x 9-11 μ.
460. On side of hill to left of upper path to Piney Prospect, September 30, 1912. Photo.
858. Dry woods southeast of Dr. Battle's, September 29, 1913. Bulb covered with rings of small scales.
1253. In poor, rather dry soil in mixed woods east of graded school, September 13, 1914. Painting.
1320. Battle's Park, woods southeast of Dr. Battle's, October 9, 1914. Bulb covered with rings of small scales as in No. 858, otherwise typical.
2374. By path along Battle's branch, just east of Dr. Battle's home, July 8, 1916.

24b. **Amanita chlorinosma** Form B. Red or Salmon.

A. megalodactyla Berk. (?)

This is a less extreme variant than Form A, and even when pronounced differs from the type species in scarcely more than smaller size and reddish color. The following brief notes will sufficiently describe it.

Collection No. 309. All parts of the volva a light salmon color; pileus covered with light salmon granules and pyramidal warts, the large bulb salmon colored on the surface; stem, gills and veil white; veil not broken up, but hung a perfect, thin delicate skirt from the very top; under side of veil covered with white meal, the granules not easily rubbed off. Spores 5.5 x 8.3 μ.

Collection No. 833. Smaller than the type. The friable meal on cap reddish brown; bulb and lower half of stem same color; upper half of stem, veil and gills white; veil very friable and falling off as usual; smell of ham. Spores white, elliptic, 5.5-7.4 x 9.2-11 μ.

Collection No. 838 was distinctly of this form; color of bulb and

lower stem nearly strawberry red, a pinkish red; color on cap had faded to a more brownish red.

Collection No. 925 was just like No. 838: cap 10 cm. broad, color of cap and bulb a rather light rosy red. Spores elliptic, 4.6-6.5 x 7.4-9.2 μ.

Plant No. 1128 was 8.5 cm. broad, light ochraceous buff to brown buff (Ridgway), densely soft-mealy in center, less densely so at margin; stem densely mealy, light creamy buff, the bulb large, long and nearly smooth, nearly color of cap; veil, as usual in this species, very fragile, covered below with soft, creamy-buff meal like the stem.

309. Battle's Park, back of Dr. Pratt's house, September 29, 1911.
833. Battle's Park, September 23, 1913. Photo.
838. Battle's Park, September 25, 1913.
925. Battle's Park, back of Dr. Pratt's house, October 16, 1913.
1128. Oak grove southwest part of "The Rocks," July 13, 1914. Photo.
1212. By path on right side of Bowlin's Creek, below "Fern Banks," July 25, 1914.
1570. In clay bank south of power house, June 23, 1915.

25. **Amanita virosa Fr.**

PLATE 68.

Cap about 5 cm. wide, evenly convex, quite smooth, shining, viscid, pure white; margin not striate. Flesh white, about 5 mm. thick in center, mild, a distinct but not strong odor of chlorine.

Gills about 6 mm. wide, moderately close, just reaching the stem, pure dull white.

Veil fragile and friable, attached at very top of stem, fragmenting into tatters and slips.

Stem solid, tapering slightly upward, squamulose-scurfy, ending below in an oval bulb, which is margined at the top by a *distinct, circular and even volval ring* about 3 mm. high.

Spores elliptic, smooth, 4.4-5.5 x 7.5-8 μ, a few up to 9 μ.

The entire plant is white and is related to *A. chlorinosma,* from which it differs in the entire absence of friable meal on cap, stem, or volva, in the distinct volval cup margin at the base, and in the smaller spores. The presence of a persistent volval cup places this

plant in complete harmony with descriptions and figures (Cooke, Gillet, Paulet) of the European *A. virosa.*

Amanita virosa of Europe is said to be poisonous and Ford has found a plant from Massachusetts, determined as this species, to contain the same deadly poisons as *A. phalloides* (Jour. Phar. and Exp. Ther. **1**: 281. 1909). It is, however, doubtful if his plants were of the same species as the one I have here described.

Hartsville, S. C., No. 10. Low woods under long-leaf pine, southeast side of Hartsville plantation, September 9, 1916. Plants lost (burned up by the cook), but spore prints saved.

26. **Amanita Atkinsoniana** n. sp.

PLATES 58, 59 AND 68.

Cap about 8 to 10 cm. wide, convex, plane, or sometimes depressed, margin even or sometimes striate, particularly after rains; surface warty in center, the warts numerous or scattered, usually about 1.5 mm. wide at base and short pyramidal; toward the margin the warts merge into soft patches or soft flocculence, both warts and flocculence easily removable by rain; warts, flocculence and center of cap a strong ashy brown (about Prout's brown—Ridgway), cap fading on margin to pallid cream. Flesh about 0.5 to 1 cm. thick near center, soft and spongy, white or with a tint of flesh color; a decided odor of chloride of lime.

Gills not crowded, just reaching stem, broadest in center or near the outer end, 5-8 mm. wide. Color pure white or creamy and sometimes stained with light reddish brown.

Veil delicate and fragile but not friable, very softly flocculent on upper side, more fibrous-flocculent below, on breaking leaving a fringe on the margin of the young cap, and forming a soft collapsed ring near top of stem, which usually soon deliquesces and flattens down to a thin yellow membrane.

Stem up to 11 cm. long above ground, 1-1.8 cm. thick in center and tapering upward, ending below in a variable bulb, sometimes quite large, at others very small, which is short or with a moderate root, the upper part covered with patches of reddish brown

(Prout's brown) soft flocculent warts which are usually arranged in more or less regular close-set rings, and extending up the stem, getting smaller and fading finally into a delicate fibrous layer that disappears on the upper parts of the stem. Flesh of stem solid and fibrous.

Spores nearly pure white (slightly creamy), no tint of olive, elliptic, 5.2-8.3 x 7.4-11 μ, most about 6.3 x 9 μ.

This plant is evidently in the *A. chlorinosma* group and is most like Form A of that species, but it differs from all others in the color of the plant, the absence of friable meal on cap, stem and veil, the rings of small warts on the stem base, and the at least somewhat less fragile character of the veil.

The species is well marked, and we have not found clearly intermediate forms between it and other members of the chlorinosma group.

759. Battle's Park, September 14, 1913. Photo. Four plants. Type.
Cap warty and flocculent, brownish ash color; bulb marked by rings of warts of same color or nearly smooth; not pruinose. Spores white, short elliptic, 5.6-7.4 x 8.5-11 μ.

824. Woods, Chapel Hill, September, 1913.
Spores 5.2-8 x 7.7-10.8 μ.

837. Dry woods, Battle's Park, September 25, 1913. Photo.
These two plants were exactly as described for No. 824 except that in one the only remnant of the veil was a torn, irregular soft fringe about 3 mm. wide hanging to the margin. It is not as friable as in *A. chlorinosma*. Spores elliptic, white, 6-8.1 x 7.2-9.9 μ.

857. Dry mixed woods, southeast of Dr. Battle's, September 29, 1913.
One plant. Color reddish brown, center with sharp warts; margin with warty scales, silky-shiny between the warts and scales; part of the veil hanging to margin, part collapsed to a yellow membrane against stem; a strong smell of old ham; gills broadest in center, where they were scarcely 5 mm. deep; white on flat surface, reddish yellow on margin where they were beginning to dry.

870. Mixed woods southeast of graded school, October 2, 1913. Two photos.
Cap brown, nearly white on margin, warted and flocculent; gills pure white, reaching stem 7 mm. deep in center. Veil delicate, flocculent, not friable, leaving a beautiful fragile fringe on margin of cap and a ring on stem about 1.5 cm. from top. Stem pure white above veil, marked with brown lines and stains below, solid, not stuffed, enlarging evenly to a good-sized long bulb which is circled at top by rings of low, soft, brown warts. Spores white, elliptic, a large oil drop, 5.5-7.4 x 7.4-11 μ.

27. **Amanita cinereconia** Atk.

PLATES 60, 61 AND 68.

Cap 3-5.8 cm. broad, irregularly plane, not at all striate, covered densely in center with a soft, more or less coherent meal of a distinct umber color (about Saccardo's umber of Ridgway), which becomes thin toward the nearly white margin; not viscid. Flesh pure white, soft, about 3-4 mm. thick at stem, almost tasteless, but with a distinct odor of chlorine as in *A. chlorinosma*.

Gills rather close, slightly attached, about 5 mm. wide, white then creamy in age, not dusky.

Veil soft, friable, remaining in part as pendants on the cap margin and in part as an imperfect and easily broken deciduous ring from the top of the stem.

Stem solid, 5-8 cm. long, including the root, about 5-7.5 mm. thick in center, nearly equal but expanding at the cap, and enlarging below more or less suddenly into a tapering root about 1.5-3 cm. long; surface densely covered near the ground with umber meal as on the cap, which extends more thinly over the entire stem: flesh solid.

Spores (of No. 2391) *white*, elliptic, smooth, 4.4-5 x 7.4-8.5 μ.

This species is nearest the olive buff form of *A. chlorinosma*, but is different enough to be treated as distinct. The main points of difference are the smaller size, distinctly *umber* color with absence of green, and the *white* spores. It differs sharply from *Amanitopsis farinosa* in the umber color, presence of a veil, pointed, rooting base, larger spores and even margin. The original description by Atkinson was made from plants collected by us in Chapel Hill, in 1908 (Ann. Mycologici 7: 366. 1909). In this description the odor was not mentioned, but fresh plants show it to be that of old ham as in other members of the *chlorinosma* group.

300. Woods south of Dr. Battle's, September 25, 1911. Photo.

2391. Oak and pine woods, hillside near barn, Glenn Burnie Farm, July 18, 1916. Two photos.

ADDENDUM.

Just as this issue was through the press we were so fortunate as to find a plant of *Amanita nitida* Fries. The specimen is entirely different from any other species we have had, and agrees well with descriptions of the European plant.

This species has been rarely met with in America and does not seem to be well understood here. It is not recognized in the *North American Flora.* Peck records it from New York and says (Rep. N. Y. St. Mus. 43: 62. 1890): "Our plant is more slender than the typical form and has smaller, but more numerous warts, but in other respects it exhibits the characters of this species." It is also reported from Maryland and California. Our plant may be described as follows:

Amanita nitida Fr.

PLATE 69.

Cap 3.5 cm. broad, hemispheric then nearly plane, regularly covered with more or less pyramidal mouse-gray warts about 1-2.5 mm. wide at base, the surface between dry and nearly pure white except in center, which may be grayish; margin not striate. Flesh 3.5 mm. thick in center, light pinkish-gray, odor rather faint but distinctly that of chloride of lime as in *A. chlorinosma,* tasteless.

Gills creamy white, moderately close, about 5 mm., broad, just reaching the stem, their edges fimbriate with the veil threads.

Stem 1.3 cm. long above the bulb, about 8 mm. thick at top, enlarging downward into a long turnip-shaped bulb about 2 cm. thick with a tapering root; surface above the bulb delicately and beautifully flocculent with soft white fibers, which in youth were extended to the veil, the bulb ringed at top with a circle of gray warts like those on the cap; flesh solid, light gray.

Veil very delicate, remarkable in being composed of very loosely woven, fine, white, frosty fibers, which begin to tear early, forming a delicate, cottony, fringe-like veil hanging from the very top of

the stem, and a similar tattered fringe on the cap margin. These threads also form a frosty fringe on the gill margins.

In the button stage the entire plant is clothed with a rather thick, soft, flocculent, gray volva, which is completely fused with the cap and bulb and which breaks up into the warts.

Spores elliptic with an eccentric mucro, smooth, white, granular when fresh, later with a large oil drop, variable in size in the same print, 5.2-6.7 x 10-13.7 μ, some only 4.8 x 7.4 μ.

That this is a member of the chlorinosma group is indicated clearly by the quite apical, fragile veil and the distinctive odor.

As this description is made from a single rather small plant, some discrepancies, due to variations, are to be expected in other collections.

2525. In path, cool damp woods just above Meeting of the Waters, June 18, 1917. Photo.

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Elisha Mitchell Scientific Society

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PROCEEDINGS OF THE SIXTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE, HELD AT THE UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL, APRIL 27 AND 28, 1917.

At 2:30 p. m. on Friday, the Executive Committee—President F. P. Venable, Vice-President H. C. Beardslee, and Secretary-Treasurer E. W. Gudger, *ex officio*; J. E. Smith, E. O. Randolph, and Bert Cunningham—met in the lecture room of the Biological Laboratory to review the internal affairs of the Academy. The Secretary-Treasurer reported that the finances of the Academy are in fine condition; that the membership on January 1, 1915, was 72, and on January 1, 1916, 88.

An invitation to hold the 1918 meeting of the Academy at the State Normal College, Greensboro, was unanimously accepted.

The following applicants for membership were elected, after which the Committee adjourned:

Beard, J. G. Associate Professor of Pharmacology, University of North Carolina, Chapel Hill.

Bonney, Miss Emma C. Instructor in Biology, Peace Institute, Raleigh.

Bottum, Miss Frances R. Instructor in Science, Saint Mary's School, Raleigh.

Dixon, L. F. Professor of Science, Weaver College, Weaverville.

Dobbins, C. N. Assistant in Geology, University of North Carolina, Chapel Hill.

Harley, G. W. Instructor in Science, High School, New Bern.

Hewlett, Dr. C. W. Professor of Physics, State Normal College, Greensboro.

MARION, S. J. Instructor in Science, High School, Raleigh.

SEYMOUR, MISS MARY F. Instructor in Biology, State Normal College, Greensboro.

UNDERHILL, G. W. Instructor in Zoology, State College of Agriculture and Engineering, West Raleigh.

At 3 p. m. President Venable called the Academy to order in regular session, and appointed the following committees: Nominating, J. J. Wolfe, J. F. Lanneau, and W. C. Coker; Auditing, Bert Cunningham and E. O. Randolph; Resolutions, George W. Lay, F. E. Carruth and Miss Margaret Wilson.

The reading of papers was then begun with some twenty-five members and a number of visitors present. Adjournment was had at 5:30, when nine papers had been called for and seven read.

At 8 p. m. the Academy reconvened in the lecture room of Chemistry Hall, where it was welcomed to the University by Dean Andrew H. Patterson.

President F. P. Venable of the Academy then gave his presidential address on the subject "The Structure of the Atom." He was followed by Professor Collier Cobb on "Typical Early Maps of North Carolina," with lantern-slide illustrations of many of the maps referred to. The Academy then adjourned to the hospitable home of Professor W. C. Coker, where a highly enjoyable smoker was had.

The Academy at 9:15 on Saturday morning met in annual business meeting. The minutes of the last meeting were read and approved. The Secretary-Treasurer reported that on January 1, 1915, there were 72 members on the roll, that 7 were lost by resignation, removal from the State and nonpayment of dues, and that 23 new members were elected, leaving the membership on January 1, 1916, at 88. The Treasurer-Secretary then read his financial report as follows, calling attention to the fact that our savings bank account was increased last year by $18, due to the fees received from the 23 new members admitted last year. The Auditing Committee then reported that the itemized statement presented by the Treasurer was correct.

Report of E. W. Gudger, Treasurer, 1916-1917

RECEIPTS

Balance last audit	$166.78
Dues since last audit	103.00
Interest savings bank account	4.99
Total receipts	$274.77
Less expenses	94.91
Balance	$179.86

RESOURCES

Savings bank balance	$131.32
Checking bank balance	48.54
Total	$179.86
Dues unpaid (about)	27.00
Stamped envelopes (about)	6.00
Estimated resources	$212.86
Estimated debts	87.75
Estimated balance	$125.11

EXPENDITURES

Proceedings, 1916	$75.00
Stationery	2.20
Printing	4.75
Postage	2.56
Secretary's dues, 1916	1.00
Secretary's expense, Raleigh	4.05
Secretary's expense, Durham	2.70
Secretary's expense, office	2.65
Total expenses	$94.91

OUTSTANDING DEBTS

Proceedings, 1916	$75.00
Printing	4.75
Miscellaneous (about)	6.00
Total (about)	$85.75

The Secretary next reported his visit to the meeting of the Southern Association of Colleges and Secondary Schools at Trinity College, and his appearance before its Committee on Curriculum. Membership could not be had in the Association by the Academy, but, thanks to the courtesy of Professor E. C. Brooks of Trinity College, a member of the committee noted above, it was possible for the Secretary, together with Messrs. J. J. Wolfe and Bert Cunningham, to meet with the committee and discuss the question of science teaching in the high school. The committee discussed mainly and was very much divided on the question of general science versus the special sciences. The Secretary opposed the teaching of general science and proposed for high schools in the country and in small towns the biological and physiographical sciences, and argued for physics and chemistry only in larger towns and cities. Domestic Science and Agriculture were favored when based on adequate preparation in Biology and Chemistry. The committee of the Association was re-

ported as in earnest about the matter, but doubtful as to what was best. Their decision was announced as deferred till the 1918 meeting of the Association.

Considerable discussion followed this report, and on motion the Secretary was appointed to attend the 1918 meeting of the Association and press upon the committee the advisability of establishing in the high schools the separate sciences as indicated above. His expenses are to be paid by the Academy.

Later in the session, immediately after the reading of the illuminating report by Professor Marion on science teaching in the high schools of the State, considerable discussion was again had, and the following motion by Professor Cunningham was carried:

> "That a committee of three from the colleges, one from each department, Biology, Physics, Chemistry, be appointed to coöperate with a similar committee from the Science section of the State Teachers' Assembly, in studying the subject of High School Science, with reference to its increased efficiency."

The committee as appointed consists of J. J. Wolfe, Andrew H. Patterson, and S. J. Marion.

The suggestion met with general approval that an effort be made in 1918 to increase our membership among the high school teachers of sciences and mathematics, and that, if members justify it, the purpose be kept in mind of forming a section in the Academy for them.

A motion was next made and carried to print the name of the Executive Committee on the program, that they might be reminded of their duties.

The Secretary then asked that members notify Professor Coker, editor of the MITCHELL JOURNAL, of changes of address and of failures to receive the JOURNAL.

The Secretary next read a letter from Mrs. Joseph A. Holmes, expressing her appreciation of the resolution adopted by the Academy one year ago on the life and services of Professor Holmes.

Professor Cobb next reported that action was being taken by Congress in the matter of mapping of our Atlantic Coastal Plain with reference to possible war conditions and needs.

The Nominating Committee then reported, and the following officers were elected for 1917-18:

President—W. A. Withers, Professor of Chemistry, State College of Agriculture and Engineering, West Raleigh.

Vice-President—J. H. Pratt, State Geologist, Chapel Hill.

Secretary-Treasurer—E. W. Gudger, Professor of Biology, State Normal College, Greensboro.

Additional members of Executive Committee:

Bert Cunningham, High School, Durham.

H. R. Totten, University of North Carolina, Chapel Hill.

H. C. Beardslee, Asheville School, Asheville.

The Committee on Resolutions next reported as follows:

Resolved, That we, the members of the North Carolina Academy of Science, hereby return our most cordial and appreciative thanks to the University of North Carolina and its President and Faculty for their hospitality and for the arrangement for our meetings which have been both pleasant and convenient; and also we thank our kind hosts and hostesses for their boundless and gracious hospitality. Especial thanks are expressed to Professor Coker for his entertainment of the Academy on Friday evening, and to the University for the delightful lunch in Swain Hall on Saturday.

At 9:50, Vice-President Beardslee in the chair, the reading of papers was begun in the joint meeting of the Academy and the North Carolina Section of the American Chemical Society. The chemical papers in the Academy and those of general interest on the Chemists' program were read.

The Chemists then withdrew and the Academy resumed its regular order of business until 1:40 p. m., when all the twenty papers remaining on the program had been read. Adjournment was then made to Swain Hall, where the scientists were entertained at luncheon by the University.

The membership of the Academy at the present time is as follows, those present at this meeting being indicated by a *:

Allen, W. M.
Andrews, Theodore
Balcomb, Prof. E. E.
Balderston, Prof. Mark
*Beard, Prof. J. G.
*Beardslee, Prof. H. C.
*Bell, Prof. J. M.
Bonney, Miss Emma C.
*Bottum, Miss Frances R.
Brewer, President Chas. E.

Brimley, Mr. C. S.
*Brimley, Mr. H. H.
Bruner, Mr. E. Murray
Bruner, Mr. S. C.
Cain, Prof. William
*Carruth, Mr. F. E.
Clapp, Mr. S. C.
*Cobb, Prof. Collier
Cobb, Mr. William B.
*Coker, Prof. W. C.
Collett, Mr. R. W.
*Cunningham, Prof. Bert
*Detjen, Mr. L. R.
Dixon, Prof. L. F.
*Dobbins, Mr. C. N.
Downing, Prof. J. S.
*Edwards, Prof. C. W.
Farmer, Prof. C. N.
Field, Mr. R. H.
*Gudger, Prof. E. W.
Hammel, Prof. W. C. A.
*Harley, Prof. G. W.
*Henderson, Prof. Archibald
Hewlett, Prof. C. W.
Hobbs, Mr. A. W.
Hoffman, Dr. S. W.
*Holmes, Mr. J. S.
*Johnson, Prof. E. D.
Kilgore, Prof. B. W.
Lake, Prof. J. L.
*Lanneau, Prof. J. F.
*Lay, Rev. George W.
*Leiby, Mr. R. W.
Lewis, Dr. R. H.
Lyon, Prof. Mary
McIver, Mrs. Charles D.
*Marion, Prof. S. J.
Mendenhall, Prof. Gertrude W.
Metcalf, Prof. Z. P.
Newman, Prof. C. L.
Nowell, Prof. J. W.
*Patterson, Prof. A. H.
Pegram, Prof. W. H.
Pillsbury, Prof. J. P.
Poteat, President W. L.
Pratt, Dr. J. H.
*Randolph, Prof. E. O.
Randolph, Mrs. E. O.
*Randolph, Prof. E. E.
Rankin, Dr. W. S.
Riddick, President W. C.
Roberts, Dr. G. A.
Robinson, Miss Mary
Seymour, Miss Mary F.
Sherman, Mr. F., Jr.
*Shore, Dr. C. A.
*Smith, Mr. J. E.
*Spencer, Mr. H.
Strong, Prof. Cora
*Totten, Mr. H. R.
*Underhill, Mr. G. W.
*Venable, Prof. F. P.
*Ware, Mr. J. O.
*Wheeler, Prof. A. S.
*Williams, Prof. L. F.
*Wilson, Prof. H. V.
*Wilson, Miss Margaret
Wilson, Prof. R. N.
Withers, Prof. W. A.
Winters, Prof. R. Y.
*Wolf, Prof. F. A.
*Wolfe, Prof. J. J.

In addition to the presidential address, which is published in full in the current number of the JOURNAL OF THE ELISHA MITCHELL SCIENTIFIC SOCIETY, the following papers were read:

Pliocene Deposits in Orange County. JOHN E. SMITH.

These occur on the divides and on the higher terraces in the plateau section of the county and generally over the Triassic area except on the floodplains and on the steeper slopes near the streams.

On the upland (elevation, 500-600 feet) this material consists of smooth, rounded pebbles and cobbles (some of which are polished) of quartz and quartzose minerals up to 6 inches or more in diameter, together with fragments of the same and of other minerals down to the size of soil particles. In the Triassic area (elevation, 250-400 feet) the deposit comprises gravel, sand, and soil (in addition to the above), in some places reaching a thickness of a foot or more. This material has been transported from a distance and characterizes the Granville soils, distinguishing them from those of the Penn series, which are derived from the Triassic rocks in place.

The thinly distributed pebbles on the higher divides of the county may be remnants of river deposits on a peneplain, but the soils, etc., of the lower interstream areas are doubtless of Lafayette age. (Illustrated with lantern slides.)

Saprolegnia anisospora in America. W. C. COKER.

This species has not before been reported in America. We have found it twice in Chapel Hill, in marshy, shaded places containing algæ. It is distinguished chiefly by the following characters:

1. The presence of spores of two or three sizes, borne usually in separate sporangia without regard to the size of the latter; the small spores from 10.5-11μ in diameter, the large ones from 13.7-14.8μ in diameter. In nearly all cultures there are formed a few very large spores, at least twice the size of the ordinary large ones, these appearing mixed in with the latter.

2. The irregular shape of the sporangia, which are not evenly cylindrical, but more or less waved, bent and constricted, and which proliferate either laterally from below, as in Achlya, or within the old ones, as is usual in Saprolegnia.

3. In sexual reproduction numerous oogonia are formed, each with one or more antheridia of diclinous origin.

The Jaws of the Great Barracuda, Sphyraena barracuda. E. W. GUDGER.

A careful description illustrated by photographs, and a specimen was given of the teeth and jaws of this fish. Their use was briefly described and some accounts of the ferocity of the fish narrated. In

the waters of southern Florida it is generally more feared than the shark, being bold and inquisitive where the shark is cowardly. The data presented is part of a paper in press in a volume of memoirs from the Tortugas Laboratory of the Carnegie Institution at Washington.

The Status of the Science Work in the High Schools of North Carolina. S. J. MARION.

This survey and report will be published in full in the forthcoming issue of the *North Carolina High School Bulletin.*

Armillaria mellea, Clitocybe cespitosa, Pleurotus sapidus, and Claudopus nidulans in Pure Culture. H. R. TOTTEN.

Mycelia of the four mushrooms were shown in pure culture on several media, also drawings of the mycelial threads as seen under high power. *Armillaria mellea* forms a slow growing, closely flocculent, cream-colored mat, and soon produces long brown to black root-like rhizomorphs. In agar these rhizomorphs are beautifully shown radiating from the mat-like central mass. The mycelium of *Clitocybe cespitosa* is much like that of *Armillaria mellea,* but the threads are not so closely woven and the rhizomorphs, or root-like bodies, are white. It is shown that *Armillaria mellea* and *Clitocybe cespitosa,* while very closely related, are not the same. The mycelium of *Claudopus nidulans* is silkier and is from white to pink in color. The mycelium of *Pleurotus sapidus*, except in old cultures, is loose and silky and is very fast growing, soon covering the medium with a mass of pure white threads. Fruiting bodies of both *Pleurotus sapidus* and *Claudopus nidulans* were shown developing in pure cultures.

Structural Geology of Orange County, N. C. JOHN E. SMITH.

With few exceptions the rocks of this county occur in long, narrow belts and "islands" extending north 65° east. Named in their order from the southeast these areas comprise the Triassic sedimentaries, granite, diorite, rhyolite, schists and greenstone, diorite, schists and phyllite, greenstone and schists, diorite, schists and greenstone, diorite, granite.

The structure of these rocks is that of a syncline, whose trough centers along the line of strike and passes near Cheek's Siding about three miles east of Mebane. Measured along the dip, this syncline is approximately twenty miles wide and probably contains folds of minor importance within it. The major joints, flow lines, etc., of the igneous rocks in many places parallel both the dip and the strike of the schists belts. Inclusions of the diorite in the granite attest the greater age of the former, and the presence of belts of igneous rocks beneath the margins of the syncline certify their contribution to the structure and prove the greater age of the schists, etc. South of Chapel Hill beyond Morgan Creek the strike is due east and west and the conglomerates, slates, and rhyolites dip to the south at an angle of 65°. (Illustrated with maps, charts, and structure sections.)

State Regulation of the Sale and Manufacture of Gas. C. W. EDWARDS.

In 1910, out of 228 cities in the United States of more than 25,000 population, only 47 had no requirements such as are in a bill proposed for North Carolina. Of these 228 cities, 103 are under State laws and have no additional municipal regulations. A number of cities, such as Baltimore, Buffalo, Los Angeles and Milwaukee, have local provisions in addition to State laws. In 1910, sixteen States had laws providing for the State inspection of meters and of the purity of gas—Connecticut, Georgia, Kansas, Maryland, Massachusetts, Nevada, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Vermont, Virginia, Washington, Wisconsin, and California. (B. of S. Circular No. 32.) Doubtless the list is now larger.

In 1910 the net income to the State of Massachusetts from meter testing alone was over $5,000. The total cost of the tests on quality, purity, pressure, etc., was assessed on the operating companies according to their sales. Meter testing is on the fee basis. There is no good reason why such a department in North Carolina would not yield a revenue to the State.

That the Corporation Commission in North Carolina should have the power and machinery at its command to protect the interests of citizens seems obvious for the following reasons: Under existing

law it is the duty of the Commission to regulate the rates to be charged by gas companies. The proper price is determined in a large measure by the quality of product sold, and this is almost at the will of the producer. Gas in New York City furnishes 680 heat units per cubic foot and is sold at 80 cents. Gas in Durham furnishes at times less than 500 heat units and is sold at $1.50. In one city in this State gas furnishing 412 heat units sold for $1.60. The standard requirement in regulated States is around 600 heat units. The difference in quality means a loss of from five to twenty thousand dollars per year to consumers in various towns of this State, and the loss would easily run into hundreds of thousands to the State at large. While it may be to the interest of certain communities to sell a cheap, poor gas, it is safe to say that it is always against public interest to have a cheap, poor gas sold at a rich, high price. To fairly meet its responsibility the Commission must know from its own tests the quality of the product sold. The consumer is entirely helpless.

Aside from the question of rates, the public is vitally interested from the standpoint of health. In the method of manufacture used by one company in this State, carbon monoxide and hydrogen are produced in equal quantities. Both of these gases are odorless and one is a deadly poison. Combined they give a cheap gas furnishing about 300 heat units. This gas causes a meter to register just as fast as a 600 heat unit gas. It is the duty of this company to carburet this gas with an oil which not only brings its heat value to standard, but gives it a very pungent odor that makes it noticeable in case of a leak. In this town a series of fatal accidents have occurred, due solely to the neglect of the service company. In other methods other deleterious elements are introduced by carelessness, so that in all cases, public interest demands systematic testing under the authority of the State.

It is just as reasonable to let manufacturers sell anything called fertilizer without tests as to composition as it is to permit of the sale of untested gas. Our duty to test meters is just as obvious as our duty to test weights and measures.

The advantages resulting from such an act would not even be principally with the citizen. An expert employed by the State to travel

from plant to plant, observing and testing, corrects irregularities and errors in manufacture that may mean thousands of dollars saved to the companies. If ammonia appears in the gas it means that a valuable by product is being lost. So it is with other errors of manufacture. The fact that meters are tested by the State brings a feeling of confidence to the consumer that is worth much to the gas companies. Uniform, improved, and economical manufacture brings new and profitable business, and this more than compensates for any costs involved.

The Pollination of the Rotundifolia Grape. L. R. DETJEN.

This paper appears in full in this number.

No abstracts have been received for the following papers:

The Relative Toxicity of Uranium Nitrate in Animals of Different Ages. WM. DEB. MACNIDER.

Trembles. FREDERICK A. WOLF.

Permanency in Fleshy Fungi. H. C. BEARDSLEE.

Sound Wave Photography (Lantern). ANDREW H. PATTERSON.

Evolution in Sponges and Changes in Classification. H. V. WILSON.

The Revision of the Atomic Weight of Zirconium. F. P. VENABLE and J. M. BELL.

Recent Investigations About Cotton-seed Meal. W. A. WITHERS and F. E. CARRUTH.

The Physics of the Shrapnel Shell. ANDREW H. PATTERSON.

Portolan Charts (Lantern). COLLIER COBB.

The Idea of Force in Mechanics. ANDREW H. PATTERSON.

The Times We Think In. GEORGE W. LAY.

The Life History of the Pecan Trunk Borer. R. W. LEIBY.

E. W. GUDGER, *Secretary.*

SOME NOTES ON THE OCCURRENCE OF LANDSLIDES

By J. S. Holmes

The serious landslides which occurred during the unprecedented floods in Western North Carolina in July, 1916, were confined largely to the area of heaviest rainfall on the southeast slope of the Blue Ridge. In the region where the first storm was the heaviest and the second carried comparatively light rainfall—as, for example, in the Highlands region—few, if any, landslides occurred. They were largely confined to the areas where the first storm, carrying from 4-10″ of rain, thoroughly saturated the soil; while the second storm, discharging from 10-23″ of rain and coming before the water of the first had time to drain off, caused a heavy supersaturation of the soil.

Damage—The damage from slides occurred in various ways. The first injury probably resulted in the carrying down into the excessively swollen streams trees and loose timbers which were washed down for many miles, sometimes lodging in or against trees, so that the river banks were washed out; at other times forming drifts against bridges which caused them to wash away. It is difficult to determine what was the actual added damage these slides caused in this way, but it must have been enormous.

Many of the local residents suffered directly from these slides: houses were struck and demolished; barns, sawmills, etc., destroyed or greatly injured; gardens and fields covered up or torn out; and crops on restricted areas ruined. No loss of life is recorded from these slides, but many narrow escapes were related.

In some places roads were injured by slides almost as much as by the high water. Railroads were perhaps even more injured in this way. Sometimes a slide occurred just above the road, possibly caused by undermining the surface of this ground; occasionally slides from above continued on past the road, carrying the road with them; often roads and especially railroads slided from the road down. Such places are exceedingly hard to repair, as there is little or no foundation for the road without digging still farther into the bank. Such repairs make excessively bad curves.

The permanent damage to the land has been comparatively small from this cause. Slides rarely exceed an acre in extent, though some have laid bare as much as four or five acres. The subsoil opened up will, in due course of time, become clothed with vegetation, but for a long time to come it will be practically barren and worthless. On the other hand, where slides have run over areas of more level land, though in many cases rich bottom-land has been covered from 1 to 3 feet deep with a subsoil of thoroughly decomposed rock, these areas can be cultivated and in a few years with proper management will probably yield fair crops.

A minor injury caused by slides is an opening up of the soil on city watersheds, allowing the ordinary rains to carry into the streams silt and mud, where previously the forest cover had prevented this. A number of such slides occurred on the Marion watershed, and the town will undoubtedly experience some trouble from this cause for some time to come. The Asheville watershed has suffered less from slides, so that probably no appreciable results will be seen.

Occurrence.—Although, so far as I am aware, no previous occurrence of slides in this region has been recorded, many of the residents of the region mentioned having seen slides at some previous time. George Bird at Marion said that during the May freshet of 1901 many slides occurred. On a branch near his house the slides brought down lots of timber. There were also cracks in the mountain-sides where the slides did not actually occur. He mentioned the fact that no subsequent rain has been sufficient to carry these still farther. Other people said that twenty-five years ago some slides occurred, though none of them remembered nearly as many as this year.

Practically all the slides occurred between about 5 o'clock Saturday evening, July 15, and 7 o'clock the following morning. The first ones were seen before dark Saturday evening, and some were seen after daylight on Sunday; they were heard at all times through that night. This was the time of heaviest rain and highest flood water. The rain slacked up about 7 o'clock in the morning, and was practically over for the day at 10 o'clock.

Many of the mountain people have their own ideas of what caused the slides. Some, even of the better informed, attributed them to

"waterspouts," namely, high columns of water coming down and striking the earth, tearing holes in the mountains where the "waterspouts" struck. Others attributed them to "cloudbursts," by which they mean nearly the same thing, though they have not as definite an idea of what a "cloudburst" is. One man at Clear Creek, in McDowell County, thought they were caused by volcanic action. He said that, undoubtedly, had it been light, a blue smoke would have been seen issuing from the rent in the earth. As corroborative evidence, he said that the earth coming from the slide had settled so hard that it was impossible to get the point of a plow into it; he had already tried. Many spoke of the night being quite light; in spite of the dense clouds and rain, a kind of white color prevailed. If so, this probably was caused by the moon, which was then nearly full.

From an economic standpoint, the study of these slides is comparatively unimportant. Only a small percentage of the mountain country was affected by them, and, even where they were worst, an insignificant percentage of the area was affected. The damage done by the slides, both directly and indirectly, would be in the aggregate considerable; but, from previous experience, there is little prospect of another such visitation in the near future. From a scientific point of view, however, they are most interesting.

Causes.—Contrary to the view of many casual observers, these landslides were in no case the result of erosion. They were caused by water *in* the soil and not *on* it. Signs of erosion were often evident in landslides, but the channels cut through the homogeneous mass of deposited soil showed conclusively that the slide occurred all at once, and what erosion there was took place subsequently.

It is very difficult, especially for such a one as myself who is not a geologist, to arrive at any definite conclusion as to the immediate cause of the slides. Undoubtedly the supersaturation of the soil with rain was the controlling cause; but this does not explain why the slides occurred in some places and not in others. Most of the larger slides occurred in slight hollows where the soil was deep and where the largest amount of water would be collected in the soil. Most of the slides from such situations came down as liquid mud, which is proved by the way in which it was plastered over the ground along its course

and the way in which it spread out in a fan shape over the level lands below. Numberless instances of such methods of sliding were seen. In such cases the surface soil matted together with tree roots or with turf, as the case might be, held together or was only partly broken up, while the semi-liquid soil below was pushed out by the weight of the surface. Many instances were seen where trees remained standing in place when the whole surface, many yards in extent, had fallen several feet down the slope.

Topography.—Though the larger number of slides occurred where the slopes were exceedingly steep, many were also found on moderate slopes, especially where the ground dropped slightly into a hollow. In fact, very few slides were seen, other than those where streams, roads or railroads had undermined a bank, except in slight hollows which normally carry no surface water. Some of the larger slides have continued from such comparatively small beginnings down branches to the open valley; but in nearly all cases these originated above the head of the surface streams.

Depth of Decomposition.—More slides seem to have occurred on the south, east, and west slopes, and fewer on the north slope. This may in part be due to the fact that in the area of heaviest rainfall there is a larger proportion of such slopes; but undoubtedly it is chiefly due to much greater depth of decomposition of the rocks on the southerly slopes. An average depth of slides was something like five or six feet, though they varied from two to 20 feet deep, and even at such depths very seldom was the solid rock exposed.

Only a small percentage of the slides which were seen carried soil from a sloping rock; that is, left exposed a rock sloping in the direction of the slide. In certain cases the slope of the bedrock seemed to be a determining cause of the slide; but such cases were few.

Nature of Rock and Soil.—Most of the slides occurred in a topsoil composed of thoroughly decomposed rock, sometimes containing large boulders. The amount of mica in the soil or rock seemed to have affected the proportion of slides only slightly. In the upper John's River Valley, for instance, there are a number of slides where the rock is evidently fairly micaceous; yet, lower down the river, there seemed quite as many where the soil is granitic gneiss, or what is

commonly called "calico rock." They most often seem to have occurred on hillsides where the rock was thoroughly decomposed to a depth of from 5 to 20 feet. Wherever the soil had in previous ages filled in the heads of depressions from above and on each side, and where the surface and subsurface water would naturally flow together in such places—even though the slope were not very great—slides might occur. In other cases, however, slides started at the tops of the hills: for example, a small hill close to Globe, where five or six slides actually started on the crest of the hill. Here, however, the slopes were very steep and the rock decomposed to a great depth. In this place there were indications of slides having occurred in previous years, probably many decades, perhaps centuries, ago.

Forest Cover.—The soil cover seems to have made little or no difference in inducing slides: they often extended a short distance above the fields into the woods, and frequently started entirely above the fields. Heavy timber on an area would sometimes seem to save it from sliding and occasionally a slide would be stopped by large trees which probably had roots in the rocks and could not easily be moved. On the other hand, some small slides seem to have been caused by the weight of some tree on earth which was supported on a sloping rock. As there was no wind during the storm, only the sheer weight of the trees, together with the large amount of water, could have had any influence in breaking the soil. The greater number of slides occurred in woodland which had been cut and burnt over; this, however, is probably because the largest percentage of the affected area is in this condition. Professor C. F. Marbut of the United States Bureau of Soils, who visited the area in company with the writer, says:

> "Given the same soil and slopes, the soil will presumably become more thoroughly saturated in a given short time in a forest covered area than on a cultivated slope where the water would run off rather than soak in."

From this it would seem that the physical features which enable the forests to retard the run-off, and thus tend to control floods during periods of normal precipitation, might even increase the liability to landslides during periods of such excessive rainfall. Conditions were

so complicated, however, that no conclusive evidence could be secured to show the influence of an ideal forest cover on landslides.

Prevention.—It would seem that there is little that can be done to prevent the recurrence of such a visitation, or even to mitigate the damage. The probability of a similar disaster occurring again in the same place seems so remote that large expenditures of money, time, and material seem hardly justified. Railroads will undoubtedly increase to some extent the size of their culverts and the heights of their bridges, and farmers may shun for a few years the mouths of hollows for new house and barn sites, but certainly no extensive measures can be undertaken. Judging by the past, it may be twenty-five, one hundred, or five hundred years before another such visitation comes to that region. When it does come, the larger the area of steep slopes at the headwaters of streams that is in well managed forests, such as the Federal Government is gathering under its ownership, the better it will be for the people of the region and of the whole State.

CHAPEL HILL, N. C.

SOME NORTH CAROLINA SOIL STATISTICS AND THEIR SIGNIFICANCE

By Roland M. Harper

INTRODUCTION

Ever since soils began to be studied from a chemical standpoint attempts have been made to correlate soil chemistry with natural vegetation,* but most of them have not been very satisfactory, partly because attention has been directed chiefly to the more conspicuous and easily identified minerals, particularly limestone, and partly because the vegetation has not been studied quantitatively. Lists of supposed calciphile and calcifuge plants were prepared long ago, but it was soon found that some species which appeared to be calciphile in one region were calcifuge in another, showing that lime was not the deciding factor. The mere presence or absence of certain species is not very significant anyway, for two areas with quite different soils might conceivably have exactly the same species of plants, but in different proportions, giving the vegetation very different aspects.

Another difficulty about making such correlations is that soil chemists have never agreed as to what method of analysis gives results most consistent with vegetation and crop yields. A complete analysis by the fusion method leaves little room for difference of opinion, but it gives no indication of how much of the total plant food becomes available in a year or in a century. (By that method a block of granite might appear equal to a very fertile soil, in everything except nitrogen.) The method used by the Association of Official Agricultural Chemists is one of the quickest, but does not do justice to the potassium.† Hilgard's acid digestion method seems to be the most significant, but it requires about a week to carry it through, and therefore has never been very popular. Mineralogical analyses are preferred by some,‡ but little progress seems to have been made as yet in correlating such analyses with vegetation and crops.

*For a summary of investigations along this line see Chapters 24 and 25 of Hillgard's Soils, 1906. See also 6th Ann. Rep. Fla. Geol. Surv., 175-177, 396 (footnotes). 1914.

†See Hilgard, Soils 340-343; Science II, 42:527-528. Oct. 15, 1915. Also, 6th Ann. Rep. Fla. Geol. Surv., 397-398. 1914.

‡See G. N. Coffey, U. S. Bur. Soils Bull. 85:86-99. 1912.

Chemical analyses of soils have fallen somewhat into disrepute in recent years, and have been largely superseded by physical or mechanical analyses, which are much more quickly and cheaply made, by passing the dry soils through a series of sieves of increasing fineness, and calculating the percentage retained by each. Although not much has been done yet in the way of correlating soil texture with vegetation, it is evident that other things being equal the finest-grained soils ought to be the most fertile, except that clay (especially if non-calcareous) and muck are often less so than the clay loams and silt loams, on account of imperfect aeration. Some of the relations between soil texture and vegetation will be brought out in the following pages.

Our knowledge of the chemistry of North Carolina soils is unfortunately very limited. There are several analyses in Emmons's reports of 1856 to 1860, but they are not strictly comparable with more modern ones. In Kerr's report on cotton production, in the 6th volume of the Tenth Census, 1884, analyses of soils from several localities, presumably made by Hilgard's method, are given, but there are not enough from any one natural region to be sufficiently representative, and some regions are not represented at all. Bulletin 57 of the United States Bureau of Soils summarizes all the chemical analyses of soils in the United States found in literature in the eighteen years preceding 1909, and there are only two from North Carolina.

Since 1900 the United States Bureau of Soils has published reports on about thirty-five counties or similar areas in North Carolina, distributed over the State in such a way as to give a pretty fair representation of the soils of each congressional district, and incidentally of every natural geographical division. In each of these reports the soils are classified according to color, texture, moisture, etc., and mapped in colors, and the area of each type is given in the text, usually in multiples of 64 acres. With the aid of the soil maps, nearly all of which are on a scale of an inch to the mile, it is a comparatively simple matter for a person familiar with the boundaries of the geographical divisions to estimate the percentage of each type of soil in each region.

To keep each of the hundreds of soil types separate in making a soil census of a whole state would require considerable space; but they

may be grouped either by series or by texture classes (*e. g.*, fine sand, stony loam, silty clay, etc.). Each series is intended to include soils having a similar origin, color, and moisture content, though varying in texture, and the name is usually a geographical one, suggested by the locality where the series was first differentiated. The number of series recognized by the Bureau of Soils has increased enormously since the first few years of soil survey work (the number was 534 on January 1, 1912, and may be nearly 1000 now), so that the later reports contain many more series names than earlier ones on neighboring or similar regions. In Bulletin 96 of the Bureau of Soils (1913) there is a long list of soil names that have been changed since publication (see page 745 for those in North Carolina), but one has no assurance that every desirable change was made there, or that other changes have not been suggested since the publication of that bulletin (which was the last of its series). Indeed in many cases the soil nomenclature cannot be revised properly without reëxamining the areas in question, at considerable expense, and subdividing some of the types as mapped into three or four.

Another difficulty about using the series names for statistical purposes is that the distinctions between different series are now drawn so finely that precisely similar soils in different areas may be referred to different series by different men, or even by the same man at different times. Furthermore, the series names are meaningless to persons not familiar with the publications of the Bureau of Soils, and have no logical sequence, while the texture classes have self-explanatory names, and can easily be arranged in approximate order of fineness.

For these reasons the soil statistics given below are based on texture only; but for each region the principal soil series are indicated. Of course the texture classes are connected by all possible gradations, and are just as liable to be interpreted differently at different times or by different men as are the series; but such errors can never be very large, and they tend to balance each other when several areas are taken together. Perhaps the greatest difficulty is the loose usage of the terms "meadow" and "swamp." At first these names were applied to many different kinds of wet soils, whether they bore meadow or

swamp vegetation or not; but the tendency has been more and more to refer such soils to definite series and texture classes.

As is well known to readers of this journal, North Carolina has two major divisions of approximately equal size: the up-country, or region of hills and hard (mostly crystalline) rocks and residual soils, and the low country or coastal plain, with sedimentary and mostly unconsolidated rocks. The boundary between these, known as the fall-line, is indicated on many easily accessible maps. Each major division can be subdivided, the up-country into mountains and Piedmont, and the coastal plain into several divisions differing in soil and vegetation more than in topography; but there seems to be no satisfactory map of the minor divisions at present. Kerr's map in the 6th volume of the Tenth Census does not separate the mountains from the Piedmont or the sand-hills and Cape Fear region from the rest of the coastal plain; and maps prepared by physiographers (such as the one in Bulletin 96 of the United States Bureau of Soils, and those by Fenneman in the 4th and 6th volumes of the Annals of the Association of American Geographers) do not subdivide the coastal plain rationally. The writer published a sketch map of the coastal plain of North and South Carolina in 1910 and 1917,* but that is now known to be inaccurate in some particulars.

In the next few pages the six divisions recognized will be taken up one at a time, and the principal soil types and series of each listed in order of area. Then to show the influence of soil on other things, the commonest trees will be listed in approximate order of abundance (as determined from the writer's car-window notes chiefly), with technical and common names, and the estimated percentage of evergreens in the forests. The names of evergreens are printed in heavier type. The number of inhabitants per square mile in 1910, the percentage of whites, the percentage of the total area classed as "improved land in farms," the acreage of improved land per inhabitant, and the expenditure for fertilizer in 1909 per acre of improved land in 1910, all of which are more or less definitely related to soil conditions, have been computed from the reports of the last United States census. It would be interesting to carry the investigation back to earlier censuses and

*Bull. Torrey Bot. Club, 37:407, 592, 1910; 44:41, 1917.

treat the subject historically, but that would take considerable time, and can be better undertaken by one who lives in the State and is better acquainted with local conditions and history.

THE REGIONS IN DETAIL

1. The mountain region covers about 9,000 square miles in the west end of the State, and is characterized by rugged topography and the highest mountains in eastern North America. Cliffs and other rock outcrops are very limited in extent, however, and almost the whole area would be arable land if it were not for the steepness of the slopes. As it is, over half the area of some of the counties is classed as improved land. Some of the richest soil is in wind-gaps high up on the ridges, and many of the summits are not rocky barrens like some of the mountains in the northern states, but excellent pastures.

The prevailing soil classes in the five or six areas that have been surveyed are loam, sandy loam, clay, black loam, sand, clay loam, and stony loam. By far the greater part of the soils have been referred to the "Porter's" series (named for a mountain in Bedford Co., Va.). Other series represented are the Chandler, Ashe, Toxaway, Talladega, and Clifton.

Apparently not over 15 per cent of the trees are evergreen, which indicates pretty good soils. The commonest species seem to be as follows:

Castanea dentata	Chestnut
Quercus coccinea	Spanish oak
Acer rubrum	Red maple
Quercus borealis maxima (formerly called *Q. rubra*)	
Quercus montana (formerly *Q. Prinus*)	Chestnut oak
Tsuga Canadensis	Hemlock
Pinus Strobus	White pine
Halesia Carolina	
Robinia Pseudacacia	Black locust
Betula lutea	Birch
Fagus grandifolia	Beech
Betula lenta	Birch

In 1910 there were 36.4 inhabitants per square mile in the mountain region, and over 90 per cent of them were white. (Two counties had more Indians than negroes.) The percentage of improved land was

28 (or 4.9 acres per inhabitant), a pretty high figure for such rough country; and the expenditure for fertilizer the preceding year was 13 cents per acre, which is considerably below the average for the United States, and far below the average for North Carolina. The remoteness of much of the region from railroad transportation may not have much effect on the amount of improved land, for the mountaineers are more nearly self-supporting than the residents of other parts of the State, but it undoubtedly does make the consumption of fertilizers less than it would be in a smoother country of equal fertility.

2. The Piedmont region, extending from Pennsylvania to Alabama, covers about one-third of North Carolina. Its rocks are of many varieties, but all metamorphic except for the Triassic areas near the eastern and northern borders (which would be worth treating separately if they were a little larger). Gneiss is perhaps the commonest rock, but there is considerable slate in the southeastern portion. The principal soil types are sandy loam, clay, clay loam, silt loam, coarse sandy loam, fine sandy loam, loam and meadow. They have been referred to fifteen or twenty series, of which the "Cecil" (named for Cecil County, Maryland), covers over half the area. Next in importance are the Durham, Georgeville, Iredell, Alamance, Granville, Congaree, Appling, Caswell, and Mecklenburg (most of which names are of North Carolina origin).

The commonest trees seem to be as follows:

Pinus echinata	Short-leaf pine
Liquidambar Styraciflua	Sweet gum
Liriodendron Tulipifera	Yellow poplar
Pinus Taeda	Short-leaf (or loblolly) pine
Quercus falcata	Red oak
Quercus alba	White oak
Quercus Marylandica	Black-jack oak
Cornus florida	Dogwood
Salix nigra	Willow
Pinus Virginiana	Spruce pine
Betula nigra	Birch
Quercus stellata	Post oak
Quercus Phellos	Willow oak
Oxydendrum arboreum	Sourwood
Platanus occidentalis	Sycamore

About 40 per cent of the total forest is evergreen.

This is the most densely populated portion of the State, having 60.4 inhabitants per square mile in 1910, 70 per cent of them white. The percentage of improved land at the same time was 37.2 (or 5.6 acres per inhabitant), and the average annual expenditure for fertilizers was $1.06 per acre, which is below the State average. The number of cultivated acres per inhabitant is the largest in the State, indicating that agriculture is the dominant industry here, in spite of the great development of manufacturing in recent decades.

3. The sand-hill belt extends from near Sanford southwestward along the fall-line to Georgia. There is some difference of opinion among geologists as to whether the sand that characterizes it is a marine Pleistocene formation or a product of weathering from the underlying Cretaceous strata. The principal soil types are coarse sand, sandy loam, swamp, and sand; and they are nearly all referred to the Norfolk series, with a sprinkling of Hoffman, Orangeburg, etc.

The commonest trees in the North Carolina portion of this belt seem to be:

Pinus palustris	Long-leaf pine
Quercus Catesbaei	Black-jack oak
Quercus Marylandica	Black-jack oak
Pinus Taeda	Short-leaf (or loblolly) pine
Nyssa biflora	Black gum
Liriodendron Tulipifera	Poplar
Pinus serotina	Black pine
Quercus cinerea	
Magnolia glauca	Bay
Liquidambar Styraciflua	Sweet gum
Acer rubrum	Red maple
Taxodium ascendens	Pond cypress

About 60 per cent of these are evergreen. A few of them are strictly confined to the coastal plain, in North Carolina at least, and some others nearly so.

This belt is too narrow to get accurate statistics for, but judging from the returns from Lee, Moore, Richmond, and Scotland counties (and making allowance for the portions of more fertile regions included in those counties) there are about 33 inhabitants per square mile, 62 per cent of them white. The improved land in 1910

amounted to about 15 per cent, or 3 acres per inhabitant, and $1.88 per acre was spent for fertilizer. The small number of acres per inhabitant indicates plainly that this region imports more farm produce than it exports. The money to preserve the balance of trade probably comes mostly from lumber and naval stores, but partly also from winter and spring visitors to Pinehurst and vicinity.

4. What may be called the short-leaf pine belt covers the greater part of the coastal plain in North and South Carolina, and in Virginia south of the James River. Although it exhibits considerable diversity in different parts, the transition from the higher and drier and more fertile portions in the north and west to the more sandy and swampy portions is so gradual that it is difficult to draw any dividing lines. The writer has recently published a somewhat detailed study of the plant population of this region, with some statistics of soils.* Since that paper was written the soil survey reports have been gone over more carefully and the statistics revised a little.

The leading soil types are fine sandy loam, sandy loam, swamp, sand, fine sand, very fine sandy loam, and coarse sand. About 60 per cent of the soils are referred to the Norfolk series, and 15 per cent to the Portsmouth. Other series represented are the Ruston, Coxville, Johnston, Kalmia, Susquehanna, Orangeburg, Hyde, and Congaree.

The commonest trees are about as follows:

Pinus Taeda	Short-leaf (or loblolly) pine
Pinus palustris	Long-leaf pine
Pinus serotina	Black pine
Nyssa biflora	Black gum
Liquidambar Styraciflua	Sweet gum
Taxodium distichum	Cypress
Taxodium ascendens	Pond cypress
Quercus Marylandica	Black-jack oak
Acer rubrum	Red maple
Magnolia glauca	Bay
Liriodendron Tulipifera	Poplar
Quercus falcata	Red oak

About 73 per cent of the forest is evergreen.

*Bull. Torrey Bot. Club, **44**:39-57. Feb., 1917

The density of population in 1910 was 42 per square mile, the percentage of whites 52.6, the percentage of improved land 27.2 (4.1 acres per inhabitant), and the expenditure for fertilizers $2.67 per acre. (The fertilizer bill of Robeson County alone was over a million dollars.) The large expenditure for fertilizer indicates a pretty high development of agriculture on a comparatively poor soil, by an intelligent class of farmers. The acreage of improved land per inhabitant is pretty close to the State average, which probably indicates that the exports of cotton and forest products are about equal.

5. In the southeastern corner of the State is the Cape Fear pine-barren region. It passes by imperceptible gradations into the adjoining short-leaf pine belt, but its boundary may be located approximately by an arc of 35 miles radius with Wilmington as a center. The topography is comparatively level for the most part, and there are many swamps and pocosins and a few savannas. Although no chemical analyses are available, the soils are doubtless the poorest in the State, on the whole, apparently not so much from any fundamental geological cause as on account of the leaching effect of summer rains. At Wilmington 49.4 per cent of the total annual precipitation comes in the four warmest months (June to September inclusive); while at Cape Hatteras, which has a greater total rainfall, only 35.8 per cent falls in those same months.*

The commonest soil types are swamp and muck (largely pocosins), sand, fine sand, fine sandy loam, and very fine sandy loam. About 40 per cent are referred to the Portsmouth series and 25 per cent to the Norfolk, with a scattering of Leon, Hyde, Congaree, etc.

The most abundant trees are the following:

Pinus palustris	Long-leaf pine
Pinus serotina	Black pine
Magnolia glauca	Bay
Pinus Taeda	Short-leaf pine
Gordonia Lasianthus	Bay
Quercus Catesbaei	Black-jack oak
Nyssa biflora	Black gum
Liquidambar Styraciflua	Sweet gum

*See Bull. Torrey Bot. Club, **37**:415–416. 1910.

Taxodium ascendens	Pond cypress
Taxodium distichum	Cypress
Liriodendron Tulipifera	Poplar
Quercus Marylandica	Black-jack oak
Acer rubrum	Red maple

The proportion of evergreens is the highest in the State, about 78 per cent. This region, being a sort of island of poor soil, bordered on the north and west by richer regions, has developed a small endemic flora, with some species almost confined to it (like the noted *Dionaea muscipula*, Venus's fly-trap), and many others more abundant here than anywhere else north of the Georgia pine-barrens. *

In calculating the density of population allowance must be made for the fact that this region contains the State's principal seaport, which is to a considerable extent independent of the surrounding country, and would be a city of some size even if all the soil within fifty miles of it were pure quartz sand. In order, therefore, to get a proper conception of just how much population the Cape Fear region is capable of supporting on its own merits we may leave out New Hanover County and take the figures for Brunswick and Pender only. In 1910 these two had 18.6 inhabitants per square mile, 56.4 per cent of them white, 8.2 per cent of improved land (or 2.8 acres per inhabitant), and spent 99 cents an acre for fertilizers. If New Hanover were included the density of population would be nearly doubled, the percentage of whites and improved land decreased a little, and the expenditure for fertilizers increased to $1.21. The small acreage of improved land per inhabitant is correlated with a large lumber and naval stores industry and commerce.

The fact that this region uses less than half as much fertilizer per acre as the evidently more fertile short-leaf pine belt may seem like a paradox; but the explanation is doubtless that agriculture is still in its infancy here, and only the richest spots are farmed, as was the case in the long-leaf pine country of Georgia a generation or two ago. By the time the percentage of improved land becomes as great here as it is now in the short-leaf pine belt no doubt a great deal more will have to be spent for fertilizers. But it would seem possible for such a

*See Bull. Torrey Bot. Club, **34**:365. 1907.

sandy region to attain a considerable development of agriculture with very little fertilizer by taking a lesson from Denmark, and importing hay and grain to feed to cattle and chickens, and exporting only things that take little or nothing from the soil, such as turpentine, honey, syrup, butter, and eggs.

6. What was designated by Kerr as the "oak and beech flats with short-leaf pine" occupies the northeastern corner of the State, east of the Nansemond escarpment, which runs almost due south from Suffolk, Va., and forms the western border of the Dismal Swamp. It is a low and flat and rather swampy region, but has probably the richest soils of any region so near the coast between Virginia and Louisiana. The amount of silt in the soil is remarkably high, and the region has somewhat the aspect of an alluvial bottom. It was indeed referred to as "bottom-land" by some of the early settlers.

There are as yet no soil surveys for the portion south of Albemarle Sound, except for Lake Mattamuskeet and its immediate shores, so the following soil data pertain only to the northern half, which is the more fertile, if the census statistics are a reliable indication. The prevailing soil types are silt loam, fine sandy loam, swamp, and loam. About four-fifths are referred to the Portsmouth series and the rest to the Norfolk (aside from Swamp, which is not put in any series). There is apparently no other area of the same size anywhere in the United States east of the Blue Ridge that has such a large proportion of silt loam.

The list of trees likewise pertains only to the northern half, for the writer has never visited the southern half, which has very few railroads. The following list is based on car-window notes taken between Edenton and the State line near Moyock, and therefore does not include any of Dismal Swamp.

Pinus Taeda	Short-leaf pine
Liquidambar Styraciflua	Sweet gum
Taxodium distichum	Cypress
Acer rubrum	Red maple
Fagus grandifolia	Beech
Pinus serotina	Black pine
Nyssa biflora	Black gum
Nyssa uniflora	Tupelo gum

Salix nigra	Willow
Quercus Phellos	Willow oak
Liriodendron Tulipifera	Poplar

Only about 38 per cent of the trees are evergreen, which is a low figure for the coastal plain. The beech, which one is inclined to associate with bluffs and ravines, seems to be more abundant here than in any other equal area in the State.*

Statistics of population and agriculture have been computed separately for the portions of this region north and south of Albemarle Sound. In the northern portion, in 1910, there were 41.6 inhabitants per square mile, 54.4 per cent of them white, 28.2 per cent of improved land (4.4 acres per inhabitant), and $1.39 per acre spent for fertilizers the previous year. The corresponding figures for the southern half are 13.7 per square mile, 69 per cent white, 6.8 per cent of improved land (3.3 acres per inhabitant), and 88 cents per acre for fertilizers. The figures for improved land per capita confirm the general impression that many of the inhabitants in the southern part depend on lumbering, fishing, stock-raising, etc., for a livelihood; and the small expenditure for fertilizers in that part can probably be explained in the same way as in the Cape Fear region.

STATISTICAL SUMMARY

Some of the statistics given in the foregoing regional sketches will now be brought together in a table for purposes of comparison, and supplemented by similar figures for the up-country and low country collectively, and for the whole State and the whole United States. The first five lines of figures have been computed from the 13th census, as already indicated, and two sets are given for the fifth and sixth regions, to show conditions in the Cape Fear region with and without New Hanover County, and for the northern and southern parts of the northeastern swamp region separately.

In the 6th line the percentage of evergreens has been estimated pretty carefully for region 4, but is only a rough guess for the others.

*According to Fernald and Rehder (Rhodora 9:112-114. 1907), the coastal plain beech is varietally distinct from the one in the mountains and northward; though they certainly look much alike. It would be interesting to determine if there is a gap between the ranges of the two forms. The fact that in the mountains of North Carolina beech is chiefly confined to the higher elevations suggests such a possibility.

The significance of the evergreen percentage is that it seems to vary inversely with soil fertility, in the eastern United States at least. *

The soil types are arranged as nearly as possible in order of increasing fineness, and the percentages are given for each, to the nearest tenth. To simplify matters some similar classes have been combined, such as rock outcrop and rough stony land; sand, sand-hill, and coastal beach; stony, gravelly, and slate loam; and swamp, muck, and meadow. Marsh (tidal or salt marsh), however, is kept separate. Percentages less than 1-20 are represented by 0, but where a given type of soil is not reported at all from a given region the space is left blank. The soil statistics for the whole United States are taken from Bulletin 96 of the Bureau of Soils, page 10. (That, however, uses a very generalized classification, with only eight types.)

	Mountains	Piedmont	Sandhills	Short-leaf Pine Belt	Cape Fear Region	Do. Without New Hanover County	Oak and Beech Flats		Up-country	Low Country	Whole State	Whole U. S.
							N.	S.				
Inhabitants per sq. mile	36.4	60.4	33.0	42.0	34.0	18.6	41.6	13.7	51.9	38.7	45.3	30.9
Per cent white	91.7	70.0	62.0	52.6	52.2	56.4	54.4	69.0	75.6	53.8	68.0	88.9
Improved land, per cent	28.0	37.2	15.0	27.2	8.1	8.2	28.2	6.8	33.7	23.2	28.3	25.1
Improved land per inhabitant	4.9	5.6	3.0	4.1	1.5	2.8	4.4	3.3	4.1	3.8	4.0	5.2
Fertilizer per acre	.13	1.06	1.88	2.67	1.21	.99	1.39	.88	.80	2.47	1.39	.24
Percentage evergreens	15	40	60	73	78	------	38	?	30	70	51	?
SOIL CLASSES												
Rock outcrop, etc.	1.0	0.1	------	------	------	------	------	------	0.4	------	0.2	?
Coarse sand	------	------	70.1	2.0	------	------	------	------	------	5.5	2.8	5.0
Sand, etc.	5.4	------	6.8	12.3	20.3		------	------	1.5	12.4	7.0	
Fine sand	------	0.1	------	4.4	19.1		2.0	------	0.	6.1	3.2	4.2
Stony sandy loam, etc.	------	0.3	1.9	0.	------	------	------	------	0.2	0.1	0.2	?
Stony loam, etc.	2.0	1.9	------	------	------	------	------	------	1.9	------	0.9	?
Coarse sandy loam	------	8.6	0.3	1.7	0.3		------	------	6.3	1.4	3.8	10.2
Sandy loam	20.6	31.6	11.7	28.2	3.8		------	------	28.6	21.8	25.2	
Fine sandy loam	1.6	7.3	------	29.9	15.3		26.3	------	6.0	25.7	16.0	16.2
Very fine sandy loam	------		------	2.1	13.7			------	------	3.6	1.8	
Loam	42.7	3.8	0.3	0.9	3.1		14.3	------	14.2	2.0	8.0	17.4
Silt loam		12.2	------	1.7	1.8		40.0		9.0	4.0	6.4	27.0
Silty clay loam		1.9	------		------		------	------	1.4	------	0.7	10.7
Clay loam	4.9	14.6	------	0.	------			------	11.9	0.	5.8	
Black loam	8.4	------					------	------	2.2	------	1.1	?
Clay	12.1	14.9	------	1.8	0.		------	------	14.2	1.4	7.6	9.3
Swamp, etc.	1.1	3.0	9.0	15.0	20.6		17.4	------	2.5	15.6	9.2	?
Marsh	------		------	?	1.9		?	------	------	0.3	0.1	?

*See Science II. 42:500-503. Oct. 8, 1915.

Some of the relations between soil conditions and density and color of population, improved land, fertilizers, and evergreens are brought out pretty well by the upper part of the table, but some disturbing factors of topography and climate have to be borne in mind. Some of these have already been mentioned. In the South negroes and rich soils generally go together, but on account of the mountains and upper part of the Piedmont being too cool for cotton, the proportion of negroes is less there than in regions of equal fertility farther south. The amount of improved land is pretty closely correlated with soil fertility except in the mountains, where topography interferes. The probable reasons for the small consumption of fertilizers in regions 1, 5, and 6 have already been mentioned.

The statistics of population, race, and improved land seem to indicate that the short-leaf pine belt has better soils than the sand-hills, while those for fertilizers and evergreens point the other way. Chemical analyses might throw some light on this paradoxical problem.

Considering now the soil texture statistics, there seems to be no area of rock outcrop or rough stony land large enough to map in the coastal plain of North Carolina (and the same might be said of the states farther north, but not of Georgia, Florida, and Alabama). Coarse sand is chiefly confined to the fall-line sand-hills. Sand and fine sand are most abundant in the Cape Fear region; and the fact that there is more sand in the mountains than in the Piedmont may be correlated with the heavier summer rains in the mountains. The various grades of sandy loam taken together are pretty evenly distributed over the State, except in the sand-hills, where the necessary clay component is scarce.

Fine sand and fine and very fine sandy loam are not common in the up-country, being more characteristic of regions where there is very little erosion going on. Loam is most abundant in the mountains and silt loam at the other end of the State, as already indicated; but just why, it is not easy to say. Clay is about ten times as common in the up-country as in the low country, just the reverse of sand and swamp; the principal reason presumably being that weathering has been going on much longer in the up-country.

College Point, New York.

POLLINATION OF THE ROTUNDIFOLIA GRAPES

By L. R. Detjen

Notwithstanding the fact that much work has been accomplished with the species *Vitis rotundifolia*, the subject of the pollination of these vines seems as little understood as ever. Persons who know the Scuppernong and other varieties of rotundifolia grapes and who have studied them for many years are very much impressed with the mysterious way in which the flowers of these varieties get the necessary viable pollen for fruit production. Time and again cases are cited where certain vines annually produce large crops of fruit, and only a very few, if any, insects are observed to visit such vines.

A vine with self-fertile flowers, under normal conditions, will usually produce at least an average crop of fruit, and there is nothing mysterious about the method in which the flowers of such vines are pollinated.

Considerable evidence collected by the North Carolina Experiment Station (Bulletin No. 209, on the "Self-sterility of Scuppernong and other Muscadine Grapes"), and corroborated by the results subsequently secured and published in "The Breeding of Rotundifolia Grapes," Technical Bulletin No. 10, and by Husmann and Dearing, (United States Department of Agriculture, Bureau of Plant Industry, Bulletin No. 273), seems to establish the fact that the present-day commercial varieties of rotundifolia grapes are self-sterile. This fact, then, calls for an explanation of how the different varieties are being supplied with sufficient viable pollen which is necessary to account for the large crops of fruit that are annually produced.

Flowers in general, that require cross-pollination, may for convenience be grouped into two general classes: (1) those that are wind-and-water pollinated and (2) those that are insect-and-bird pollinated. The flowers of the first class generally are deficient in odor, nectar glands, and bright colors.

For self-evident reasons we may omit in our present discussion water and birds as agents in the transportation of grape pollen.

Among wind-pollinated flowers we usually find prevailing a type of pistil with a comparatively long style and a feathery stigma, the

function of which is to catch wind-borne pollen. Such pistils are not associated with flowers of *Vitis rotundifolia*.

Pollen that depends on wind for its successful distribution is usually of a light and dry character. This is especially true among dioecious plants where the stamens and pistils of the flowers are borne on separate plants, and where the pollen must often be carried long distances in order to reach the pistillate plants.

On the contrary, flowers that depend on insects for the transportation of pollen generally produce pollen grains which have a waxy surface, and which, therefore, will easily cling to the hairs and other parts of insects with which they may come in contact. Very often, instead of having a waxy coat, the pollen grains are flattened, angular, or may be covered with spiny protuberances which materially assist the pollen grains to adhere to foreign objects. Nectar glands, odors, or bright colors are usually well developed, by means of which insects might easily be attracted.

That the flowers of rotundifolia grape vines depend mainly on insects for the transportation of this pollen becomes more apparent the closer we examine the individual parts of the flowers. The floral parts that indicate cross-pollination by insects, and which we shall briefly discuss here, are the following: (1) character of pollen, (2) odor, and position of flowers on vine, (3) nectar glands, and (4) character of the pistil in the flower.

By dipping a dry camel's-hair brush into a vial of freshly gathered rotundifolia grape pollen one can easily detect the waxy coat of the pollen grains. The hairs become dusted with the powdery element, and vigorous jarring alone will dislodge the pollen grains from the brush.

While the flowers of neither the staminate nor of the imperfect hermaphrodite vines are of a showy character, insects are quickly attracted to them because of their penetrating sweet odors. This is especially important to the flowers, because many of them are located deep under the leafy canes where, but for the sweet odors, they might go unnoticed and therefore unpollinated. Not only is the pollen very fragrant, but nectar is secreted by glands, five or more, which are

situated between the stamens at the base of the pistil. In the staminate flowers the glands cover the greater part of the upper surface of the receptacle, while in the imperfect hermaphrodite flowers they form almost a continuous ring of glandular tissue at the base of the ovary.

The pistils of the grape flowers, because of their small size, are not well adapted to catch wind-borne pollen, and the position of many flower clusters under dense foliage makes it practically impossible for them to catch pollen that is carried by the wind.

The evidence presented seems quite sufficient to exclude wind as the principal agent in the pollination of rotundifolia grape vines, and points out clearly that this great work is laid at the feet of some humble insect.

INSECTS OBSERVED ON OR ABOUT ROTUNDIFOLIA GRAPE VINES

What insect or insects accomplish the pollination of the fruit-bearing rotundifolia grape vines always has been a matter of speculation. The North Carolina Experiment Station Bulletin No. 209 mentions "honey bees" and "various flies" as being the most important carriers of pollen. Husmann and Dearing (U. S. Dept. Agr., Bureau of P. I. Bulletin No. 273) mention a small "long-horned beetle, *Copidita thoracica*," and a small "bee-like fly" as being the most active among pollen carriers.

It is true that many insects frequent the more exposed flower clusters of staminate vines, but not so many can be observed to explore the inner and deeper recesses of dense, foliacious fruit-bearing vines when in search of pollen and nectar. While the exposed flower clusters are most easily accessible to insects and more fruit is produced on these clusters, nevertheless, very fine and luscious fruits are not infrequently gathered from the most leafy parts of the vine. This fact seems to indicate that the flowers of the fruit-bearing vines are diligently sought out by some active insect, presumably for the nectar.

Among the insects that were observed to visit the flowers of fruit-bearing rotundifolia grape vines the following are deemed the most important: (1) short-tongued or mining bees (Fam. *Andrenidæ*), (2) bees of the family *Megachilidæ*, (3) honey bees (*Apidæ*), and (4) a soldier beetle (*Chauliognathus marginatus*).

By a comparative study of all the insects that visit the staminate and perfect flowered rotundifolia grape vines, the source of all viable pollen, we come to the conclusion that bees are the best adapted for the transportation of pollen. Their bodies are densely covered with branched hairs where the pollen grains become entangled and thus are carried about from flower to flower. Most of the bees possess specialized hairs, either on their last pair of legs or on their abdomen, which hairs are collectively spoken of as "pollen baskets." These specialized devices at times are so filled with pollen that the yellow masses can be seen at some distance. Of course, these pollen baskets are not such mechanical devices from which no pollen ever escapes or is lost; on the contrary, when the bee rambles over the flower in search of more pollen and nectar, these baskets come in contact with the moist stigmatic surfaces of the pistils and thereby lose a part of their contents. A sufficient number of the pollen grains are thus caught and held by the pistils to effect fertilization, and fruit production is the result.

The bees that were most commonly observed on flowers of both types of vines were of the group known collectively as short-tongued or mining bees. Very often, and probably more commonly, these insects are known by the name of "sweat bees" because of the persistence with which they hover about perspiring field laborers. These insects are small and light, which enables them to travel rapidly over the flower clusters, and their bodies and legs, being short, causes them to come in close contact with the pistils every time they try to get nectar. Their flight from vine to vine, and from cluster to cluster, is so rapid and so noiseless that, unless actually observed, one would not even suspect their presence on the vine.

Under these conditions it is no longer a miracle that the flowers on rotundifolia grape vines become pollinated and bountiful crops of fruit are produced.

Bees of the family *Megachilidæ*, and honey bees (*Apidæ*) also have been observed to visit both types of flowers of the rotundifolia grapes. Of these, the former are probably the more important, and this for two reasons: (1) because they were observed to be more frequent visitors, and (2) because their pollen-carrying apparatus is larger and

so well situated that all the flowers over which they travel are bound to become pollinated.

Instead of having pollen baskets on the legs like most of the others, these bees carry pollen in baskets that are situated on the ventral side of the abdomen. In fact, nearly the whole underside of the abdomen bears specialized hairs which collectively form the large pollen basket.

Honey bees have been observed in very small numbers to frequent the flowers of fruit-bearing vines, and therefore they should be classed as of less importance in regard to the pollination of rotundifolia grape vines.

Beetles generally are poor pollinators, and this for two reasons: (1) because their bodies are generally smooth—specialized hairs for carrying pollen are not known to occur on beetles—and (2) their slow progress from flower to flower is too clumsy a means of transportation where many flowers are to be pollinated daily.

Among the beetles that were most commonly observed on flowers of the grapes, *Chauliognathus marginatus* was the most abundant always. The body covering of this beetle is minutely hirsute, and with the aid of a hand lens one can very often see adhering pollen grains, especially about the regions of the thorax and legs. The beetle is a voracious feeder on pollen, and frequently has been observed to devour the entire stigma and style of the flowers. This habit of the beetle would brand him rather a destroyer than a producer of fruit crops. However, it is possible that during his rambles he may scatter enough pollen to class him among the pollinators of the vine.

Other beetles that were observed to feed on grape pollen are the following: a small black blister beetle, twelve-spotted cucumber beetles, and striped cucumber beetles. These were seen only in exceedingly small numbers, and judging from their habits they are unimportant as far as the pollination of the grape is concerned.

While flies of many species were observed to be on the flowers of staminate vines, only a very few ever visit the flowers of the fruit-bearing vines. The habits of these small flies are such that pollen seldom clings to their bodies, and therefore with them the transportation of pollen becomes a negligible factor.

EXPERIMENTS CONDUCTED WITH INSECTS

In order to try out the efficiency of insects as pollinators of the grape, two groups, that had been observed frequenting the flowers of both types of vines, were selected, and the results obtained are made the basis of this presentation. The two groups of insects thus chosen are (1) the short-tongued or mining bees of the family *Andrenidæ,* (2) a soldier beetle, *Chauliognathus marginatus.* Of these two groups of insects, the bees seemed the more important because of the immense loads of pollen that they gather and carry from flower to flower, and because of their pronounced greater activity among the flowers. In the spring of 1916 the mining bees were observed to be by far the most numerous visitors on all types of rotundifolia grape vines. The second group, *C. Marginatus,* for many years has been observed to be very abundant among the flowers, and because of their somewhat hirsute coat they were considered worthy of investigation.

The methods used to test these insects as to their propensities for hunting out and pollinating rotundifolia grape flowers may be described as follows: Suitable flower clusters were selected and prepared, by removing all the open flowers, and then inclosed in cloth bags of varying sizes. Usually on the following day the flowers began to open and were ready for pollination. The insects were captured alive on a staminate vine by means of a glass test tube and immediately liberated within the cloth bags, one insect to the bag per day. The bags were then re-tied and the inclosed flowers were left to their fate.

The cloth bags were conveniently large and allowed the imprisoned insects plenty of space to avoid crossing the flower clusters if the insects took such a notion. The smallest bag measured no less than 6x12 inches and the largest bag 12x18 inches.

Twelve of such bags were used on a Sanmonta vine, twelve on a James vine, and five on a fruit-bearing seedling vine. In each case two of the bags were retained as a check on the results that might be obtained in the other bags. It was the intention originally to have all of the bags cover flowers on the same variety, but as the work was done during the latter part of the blooming season, a lack of sufficient flower clusters on one variety made it necessary to utilize several.

The ultimate result, a normal typical fruit cluster, should be obtained in each case.

It so happened that the bees were liberated in the bags which covered flowers of Sanmonta, and the beetles in the bags which covered flowers of James and of the seedling vine. In the case of the ten bags on Sanmonta and of the ten bags on James, the captive insects were simply liberated within these bags; but in the case of the bags on the seedling vine the beetles were actually brushed, although lightly, over the flowers and the beetles themselves were thrown away. It will be noticed that the work on this last vine was simply to find out whether the beetles actually carried viable pollen on their bodies and whether this pollen might be easily detached and thus pollinate flowers over which the insects traveled. The results of the experiment are indicated in the following table:

Bags	Bees (Fam. Andrenidae) on Sanmonta		Beetles (Chauliognathus marginatus) on James		Beetles (Chauliognathus marginatus) on Seedling	
	Number Fl. Clusters	Number Berries	Number Fl. Clusters	Number Berries	Number Fl. Clusters	Number Berries
1	1	11	1	0	1	1
2	2	35	1	0	1	-------------
3	2	32	1	0	1	13
4	2	57	1	0		
5	1	18	1	0		
6	1	15	1	0		
7	1	33	1	0		
8	1	14	1	2		
9	2	37	2	7		
10	1	28	1	4	-------------	-------------
Totals	14	280	11	13	3	14

From the above table we learn that the short-tongued or mining bees proved to be by far the more effective in the dissemination of pollen and the production of fruit. Every bag into which bees had been placed contained at least some fruits, and in most cases good size typical clusters.

The effect of the beetles is not so marked. Seven of the bags which had contained a beetle apiece did not set a single fruit. The three remaining bags contained two, seven, and four berries respectively.

The effect of brushing newly caught beetles over receptive flowers was a little more marked. One of the bags contained one berry, one contained no fruit, and the third contained a cluster of thirteen berries.

The check bags, six in all, two on each variety, contained not a single berry. This result simply indicates the self-sterility of the vines in question.

SUMMARY

Judging from the types of insects and of their numbers that were observed to visit flowers of the rotundifolia grape vines, it may be stated that bees constitute the most important group. Of this great group, the short-tongued or mining bees (Family *Andrenidæ*) sometimes known as "sweat bees," are the most important, and chiefly responsible for the cross-pollination of all varieties.

Bees of the family *Megachilidæ* have been observed to visit flowers of the fruit-bearing rotundifolia grape vines and are responsible for the pollination of many flowers. Because of the smaller numbers of these bees, however, they are of only secondary importance to those of the family *Andrenidæ*.

Honey bees (Family *Apidæ*) have been observed in but very small numbers on vines of the fruit-bearing kind, and, while they may effect some cross-pollination, are relatively unimportant in the production of regular fruit crops. This contention is borne out by the poor results that were obtained in large commercial vineyards where honey bees were kept for the sole purpose of cross-pollination.

Several species of beetles have been observed to feed on pollen from rotundifolia grape vines. Of these, *Chauliognathus marginatus* has in a limited way shown itself capable of cross-pollinating grape flowers. The effect of these beetles on the regular fruit crop, however, is so slight that they need not be given much consideration as pollen carriers.

Flies, from their very habit and character, do not produce noticeable, if any, cross-pollination of the rotundifolia grape vines, and can be safely ignored in regard to the pollination of the grape.

RALEIGH, N. C.

THE DIORITES NEAR CHAPEL HILL, N. C.

By John E. Smith

It is generally believed, and frequently stated, that diorites are not common in the United States; and such is true of certain large areas. In North Carolina, Virginia, and I believe in the Piedmont and in the Blue Mountains south of the Potomac River, relatively large areas of this rock are found, being known in Caldwell, Rowan, Forsyth, Caswell, Alamance, Orange, and other counties in North Carolina. In this State, however, the diorites on the average constitute not more than one-tenth of the igneous rocks and are irregularly distributed throughout the Piedmont and Mountain sections. These occur as strips or in belts, and sometimes in small circular areas, lying parallel to the direction of the strike, which is in general northeast and southwest. These belts or stocks vary in size up to three miles or more in width and up to a length of ten to twenty miles or more. Some of them are ribbon-like in shape, some are irregularly ellipsoidal, and part of the finer grained ones occur as schlieren and possibly as dikes in granite.

A stock of "granite" extends along the southeastern edge of Orange County. On the west of this a belt of diorite parallels the granite with which it is in contact, passing through Carrboro just west of Chapel Hill. West of this belt of diorite the schists dip sharply to the northwest and the sheeted structure in the diorite lies normal to this dip. One set of joints is approximately parallel to the dip and the other nearly normal to it. Both dip faults and strike faults occur in or near this belt of rocks, and dikes are found cutting it in various places. These dikes consist chiefly of basic rocks and vary in size from one foot up to fifteen feet or more in width, a few being much larger than this. Veins of secondary minerals, such as calcite, quartz, and epidote, also occur in the diorite. The veins of calcite and epidote are very narrow, seldom exceeding an inch in width, but the quartz veins sometimes reach a size of two feet or more. Near the contact margin between the diorite and the granite inclusions of the former occur frequently in the latter, showing the greater age of the diorite.

Within the belt of diorite occur long narrow lenses of gabbro, some of which have a maximum width of four hundred yards and are half a mile or more in length.

PETROGRAPHY

In hand specimens the rock is coarsely holocrystalline, granitic, but sometimes occurs in finer-grained texture, with about equal amounts of light and dark minerals. In a few places porphyritic texture is developed in limited areas and also irregular spherical areas of granite a few feet in extent. In the schlieren the texture is finer grained, but holocrystalline and the dark minerals predominate. Within three feet of these segregations the texture is somewhat gneissoid, the layers being roughly parallel to the border of the dark "patches," which in some cases are circular in outline.

Microscopic examinations were made of typical specimens taken from the outcrop at the foot of Clover Hill near the new bridge on the Hillsboro road. In this section the crystals of the diorite are seen to be hypidiomorphic in form. Oligoclase is the predominating mineral, approximating 40 per cent of the total. The hornblend nearly equals the feldspar in quantity, and with 15 per cent of epidote, about 5 per cent of quartz, a small amount of albite, and the accessory minerals, apatite, zircon, and magnetite, makes up the remainder of the rock. Oligoclase and the accessory minerals have the most distinct crystal boundaries.

Between crossed Nicols the oligoclase crystals almost without exception are seen to inclose a central rectangular area of minute indeterminable inclusions. These areas are surrounded by clear border zones having about one-fifth the width of the crystals and exhibiting clearly narrow parallel striations due to polysynthetic twining. Rarely can striations be seen among the inclusions. In a few instances medium-size crystals show only a single circular row of inclusions inward from the margin about one-fourth the width of the crystal. Numerous needles of apatite occur largely as inclusions in the plagioclase crystals. Only one crystal was seen to exhibit faulting, and a few small patches of micropegmatite were observed. The faulting seen in this crystal was caused by crushing after the rock solidified,

and was probably obtained near a fault plane. The porphyritic phase of the diorite exhibits long, narrow phenocrysts of green hornblend in a matrix similar to the other portions of the rock. The order of crystallization is as follows: apatite, magnetite, oligoclase, hornblend, and quartz.

The following analyses of the diorite showing the chemical composition of the rock were made by Mr. W. L. Goldston, Jr.:

No.	SiO_2	Al_2O_3	FeO Fe_2O_3	CaO	MgO	P_2O_5	SO_3	K_2O Na_2O_3	H_2O	Total
1	53.25	17.72	4.65	9.82	1.22	1.75	.89	9.81	.62	99.73
2	62.97	15.90	2.75	8.46	2.24	.78	.77	3.60	2.75	100.22

No. 1 is the fresher rock at the base of Clover Hill. No. 2 is the altered product of it from an elevation about thirty feet higher.

PETROGRAPHIC RELATIONS

This area is on the eastern margin of the "Schist and Slate Belt," which in every county where it occurs is broken by igneous rocks. The long stock of "granite," which includes members of the diorite, gabbro, and peridotite families, passing through southeastern Orange County, constitutes a petrographic province of much interest. It is everywhere cut by dikes chiefly of basic rocks, including basalt, diabase, limburgite, and limburgite porphyry and some unidentified dark-colored rock very fine-grained in texture. The "Iron Mine" is located just beyond the main belt of diorite, to the northwest. That this body of mineral, chiefly magnetite and hematite, is a dike (a series of dikes northward) is shown by the apophyses entering the weathered wall-rock from it and by the upward curved foliæ of the schisted wall-rock in contact with it. As far as they have been identified, the dike rocks are chiefly complementary.

Granite, at Chapel Hill, one-fourth mile from diorite belt. In this section the following minerals are shown to be present: quartz, microcline, oligoclase, hornblend, epidote, and pyrite. Inclusions are seen in quartz, oligoclase, and microcline. The oligoclase crystals have the usual clear narrow border, with parallel striations, inclosing a large inner area of minute indeterminable inclusions which make

up the major portion of the areas of the crystals. There are inclusions of hornblend in some of the microcline. The hornblend occurs sparingly and is partially altered to chlorite. Epidote is present as a secondary mineral.

Syenite near margin of diorite. This section shows the rock to be chiefly oligoclase, with distinct crossed lamellæ in most of the crystals. The inclusions are coarser than those in the granite, and in some instances are oriented in two directions, parallel to each set of the crossed lamellæ. The clear margins of the crystals of oligoclase are about one-tenth the width of the crystal. Small amounts of hornblend, epidote, quartz, and apatite are present.

These and other sections examined reveal the fact that there is a somewhat uniform decrease of quartz and microcline toward the diorite from Chapel Hill and a corresponding increase of oligoclase and hornblend.

ORIGIN

The coarse granitic texture of the rock is sufficient evidence of its plutonic origin. The lens of gabbro at Carrboro and that half a mile northwest of Clover Hill, lying wholly within the belt of diorite and parallel to its principal direction, suggest magmatic segregation as the origin of the gabbro. This, with the relation of the diorite to the granite on the southeast, suggests that the entire group of rocks constitute a stock the long and narrow members of which were derived by differentiation as the magma solidified. The central axis of this stock probably lies along the area of pink granite half a mile or more from the diorite. This origin would also account for the schlieren in the granite and for the spots of granite in the diorite. It is younger than the schists, slates, etc., having cut and folded them, and older than the Triassic sediments resting unconformably on it to the east. Though usually considered as Archean, it is not definitely known to be of that age.

ALTERATION

From the chemical analyses given it will be seen that the silica and water content increase and that the alkalis decrease as the process of weathering proceeds. Examination of the rock in thin section re-

veals the fact that the oligoclase, hornblend, and magnetite on decomposition give rise to epidote, albite, calcite, and limonite. It is not probable that all of these minerals occur throughout the diorite belt; in one place calcite veins are found; in another veins of quartz, and elsewhere veins of epidote. The chief processes involved in these changes are hydration and carbonation, which, with oxidation, disintegration, etc., and the additional work of organic agencies, with some sedimentary material, form the soils known as the Iredell series.

CHAPEL HILL, N. C.

LIST OF PLANTS FROM BATESBURG, S. C., AND VICINITY

By E. A. McGregor

While stationed at Batesburg, S. C., for a period of five years, at which point I was engaged in the investigation of the common red spider, I utilized some of my spare moments in the collection of the native plants of that locality. The results are recorded in the list that follows. I may say that the collection was almost entirely named by the systematic staff of the Bureau of Plant Industry of the United States Department of Agriculture. The collection is now a part of the Dudley Herbarium at Stanford University.

POLYPODIACEÆ

Polypodium polypodioides (L.) Hitchc. January 10, 1915; July 16, 1915.
Lorinseria areolata (L.) Presl. August 20, 1913.
Athyrium Filix-femina (L.) Roth.
Polystichum acrostichoides (Michx.). Scott.

PINACEÆ

Pinus taeda (L.). May 12, 1914.
Pinus rigida Mill. May 12, 1914.
Pinus virginiana Mill. May 12, 1914.
Pinus echinata Mill. May 12, 1914.
Pinus palustris Mill. May 12, 1914.
Chamaecyparis thyoides (L.) BSP. Steedman, S. C. May 30, 1913.

THYPHACEÆ

Typha latifolia L. August 12, 1915.

POACEÆ

Paspalum angustifolium LeConte. July 15, 1913.
Paspalum glabratum Engelm. July 31, 1915.
Panicum scoparium Lam. June 25, 1915; August 20, 1913.
Panicum anceps Michx. July 31, 1915.
Panicum Boscii Poit. May 11, 1912.
Panicum commutatum Schult. May 11, 1912.
Panicum xalapense H. B. K. April 16, 1913; May 24, 1913; May 6, 1912.
Panicum microcarpon Muhl. July 20, 1913.
Phleum pratense L. June 25, 1915.

Holcus halepense (L.) Pers. July 15, 1914; August 12, 1915.
Poa annua L. April 21, 1914.
Dactyloctenium aegyptium (L.) Richter. August 12, 1915.
Arundinaria tecta (Walt.) Muhl. July 31, 1915.

CYPERACEÆ

Cyperus pseudovegetus Stend. July 15, 1913.
Cyperus strigosus L. August 1, 1913.
Eleocharis tortilis (Link.) Schultes. July 15, 1913.
Carex stipata Muhl. May 6, 1912.
Carex lurida Wahl. May 24, 1913.
Carex intumescens Rudge. April 16, 1911.
Carex verrucosa Muhl. August 20, 1913.

ARACEÆ

Arisaema triphyllum (L.) Schott. April 21, 1912.
Orontium aquaticum L. Steedman, S. C. May 16, 1914.

ERIOCAULACEÆ

Dupatya flavidula (Michx.) Ktze. May 30, 1913.

JUNCACEÆ

Juncus scirpoides Lam. June 25, 1915.
Juncus debilis A. Gray. May 6, 1912.
Juncus acuminatus Mx. April 16, 1911.

LILIACEÆ

Chamaelirium luteum (L.) Gray. July 15, 1913; May 12, 1914.
Oakesia sessilifolia (L.) Wats. April 4, 1911.
Allium canadensis L. May 24, 1912.
Allium mutabile Michx. May 20, 1913; May 30, 1913.
Muscari racemosum (L.) Mill. August 12, 1915.
Yucca filamentosa L. July 15, 1914.
Polygonatum commutatum (R. & S.) Dietr. April 29, 1911.
Smilax rotundifolia L. April 24, 1912.
Smilax laurifolia L. April 24. 1913.
Smilax pseudo-China L. April 29, 1911.
Nemexia Hugeri Small. July 31, 1915.

AMARYILLIDACEÆ

Hypoxis hirsuta (L.) Coville. April 29, 1911.

IRIDACEÆ

Iris versicolor L. May 13, 1913.
Sisyrinchium fibrosum Bicknell. April 24, 1912; May 6, 1912.
Sisyrinchium sp. April 16, 1911.

ORCHIDACEÆ

Gymnadeniopsis clavellata (Michx.) Rydb. August 20, 1913.
Pogonia ophioglossoides (L.) Ker. Steedman, S. C. May 16, 1914.
Limodorum tuberosum L. Steedman, S. C. May 30, 1913.
Spiranthes cernua (L.) Richard. June 15, 1912.
Tipularia unifolia (Muhl.) BSP. August 30, 1913.

SALICACEÆ

Salix nigra Marsh. July 16, 1915.

JUGLANDACEÆ

Juglans nigra L. July 31, 1915.
Carya ovata (Mill.) K. Koch. July 31, 1915.

BETULACEÆ

Alnus rugosa (Dupoir) K. Koch. April 24, 1913.

FAGACEÆ

Quercus virginiana Mill. April 26, 1914; August 1, 1913.
Quercus nigra L. Steedman, S. C. May 16 1914.
Quercus nigra L. August 1, 1913.
Quercus alba L. August 1, 1913.
Quercus stellata Wang. Steedman, S. C. May 16, 1914.

URTICACEÆ

Celtis georgiana Small. July 31, 1915.
Boehmeria cylindrica (L.) Sw. August 20, 1913; September 7, 1911.

LORANTHACEÆ

Phoradendron flavescens (Pursh) Nutt. June 25, 1915.

POLYGONACEÆ

Rumex obtusifolius L. July 15, 1911.
Rumex crispa L. August 12, 1915.
Rumex acetosella L. April 18, 1911.

Polygonum Sp. May 6, 1914.
Persicaria Persicaria L. August 12, 1915.
Persicaria hydropiperoides (Michx.) Small. June 15, 1912.

CHENOPODIACEÆ

Chenopodium Botrys L. August 20, 1913.
Chenopodium album L. July 31, 1915.

AMARANTHACEÆ

Amaranthus spinosus L. July 31, 1915.
Amaranthus hybridus L. August 12, 1915.
Amaranthus retroflexus L. July 31, 1915.

PHYTOLACCACEÆ

Phytolacca decandra L. May 24, 1912.

CARYOPHYLLACEÆ

Stellaria media (L.) Cyrill. June 10, 1915.
Silene antirrhina L. May 9 1914.

NYMPHAEACEÆ

Castalia odorata (Dryand.) W. & W. Steedman, S. C. May 30, 1913.

RANUNCULACEÆ

Ranunculus pusillus Poir. April 16, 1911.
Clematis viorna L. April 16, 1911.
Actaea alba (L.) Mill. July 31, 1915.

MAGNOLIACEÆ

Magnolia virginiana L. May 24, 1912.

CALYCANTHACEÆ

Calycanthus floridus L. May 6, 1912.

ANONACEÆ

Asimina triloba (L.) Dunal. May 24, 1913.

CRUCIFERÆ

Lepidium virginicum L. June 10, 1915.
Coronopus didymus (L.) Sm. May 6, 1914.
Brassica oleracea L. April 21, 1914.
Sisymbrium Thalianum (L.) Gay. April 24, 1912; May 2, 1914.

SARRACENIACEÆ

Sarracenia rubra Walt. May 16, 1914.

DROSERACEÆ

Drosera intermedia Hayne. Steedman, S. C. May 30, 1913.

CRASSULACEÆ

Penthorum sesoides L. July 15, 1913.

SAXIFRAGACEÆ

Heuchera americana L. May 12, 1914.
Itea virginica L. May 13, 1913; May 12, 1914.

HAMAMELIDACEÆ

Liquidambar styraciflua L. May 24, 1912.

ROSACEÆ

Crataegus spathulatus Michx. May 6, 1912.
Crataegus Vailiae Britt. April 24, 1912.
Crataegus munda Beadle. April 21, 1912.
Crataegus Beadlei Ashe. May 6, 1912.
Duchesnea indica (Ande.) Focke. May 6, 1913.
Potentilla caroliniana Poir. April 24, 1912.
Potentilla canadensis L. April 16, 1911.
Rubus nigrobaccus Bailey. June 25, 1915.
Rubus floridus Tratt. May 6, 1912; April 16, 1911.
Rubus sp. May 6, 1912.
Agrimonia mollis (T. & G.) Britt. July 31, 1915.
Agrimonia incisa T. & G. August 20, 1913.
Rosa humilis Marsh. May 24, 1913.
Padus virginiana (L.) Reich. July 31, 1915.
Prunus umbellata Ell. July 31, 1915.
Prunus umbellata injacunda (Small) Sargent. April 24, 1912.
Prunus angustifolia Marsh. April 24, 1912.

LEGUMINOSEÆ

Morongia uncinata (Willd.) Britt. July 15, 1911.
Chamaecrista nictitans (L.) Moench. September 7, 1911.
Chamaecrista fasciculata (Michx.) Greene. August 20, 1913.
Baptisia bracteolata Ell. April 29, 1911.
Baptisia tinctoria (L.) R. Br. May 30, 1913.
Crotalaria sagittalis L. July 15, 1914.
Lupinus villosus Willd. April 19, 1914.
Trifolium procumbens L.
Trifolium pratense L. August 12, 1915.
Trifolium arvense L. July 15, 1914.
Trifolium repens L. August 12' 1915.
Medicago arabica Huds. May 6, 1914.
Psoralea pedunculata (Mill.) Vail. June 2, 1913.
Robinia Elliottii (Chapm.) Ashe. May 30, 1913.
Cracca spirata (Walt.) Ktze. July 15, 1911.
Cracca virginiana L. May 30, 1913; May 16, 1914.
Wisteria frutescens (L.) Poir. April 16, 1911.
Meibomia Dillenii (Darl.) Ktze. September 20, 1911.
Meibomia nudiflora (L.) Ktze. July 15, 1913.
Lespedeza striata (Thunb.) H. & A. Octcber 30, 1915.
Lespedeza frutescens (L.) Britt. September 7, 1911.
Stylosanthes riparia Kearney. June 25, 1915.
Stylosanthes biflora (L.) BSP. May 24, 1913.
Vicia sativa L. June 25, 1915.
Strophostyles umbellata (Muhl.) Britt. August 20, 1913.
Bradburya virginiana (L.) Ktze.
Amphicarpa monoica Ell. September 7, 1911.
Galactia regularis (L.) B. S. P. August 20, 1913; July 15, 1913.
Dolicholus simplicifolius (Walt.) Vail. May 30, 1913.
Dolicholus erectus (Walt.) Vail. July 15, 1913.

LINACEÆ

Linum medium (Plan.) Britt. July 15, 1911.
Cathartolinum striatum (Walt.) Small. July 31, 1915.

OXALIDACEÆ

Ioxalis violaceae (L.) Small. April 21, 1912; May 12, 1914.
Xanthoxalis stricta (L.) Small. April 23, 1914; April 16, 1911; April 21, 1912.

GERANIACEÆ

Geranium carolinianum L. May 6, 1912; March 9, 1914.
Geranium maculatum L. April 20, 1914.

POLYGALACEÆ

Polygala lutea L. May 30, 1913.

EUPHORBIACEÆ

Cnidoscolus stimulosus (Michx.) Engelm. May 24, 1913
Stillingia sylvatica L. May 30, 1913.
Euphorbia paniculata. April 21, 1912.
Tithymalopsis sp. May 24, 1912.

ANACARDIACEÆ

Rhus Toxicodendron L. April 21, 1912; May 20, 1913.
Rhus radicans L. April 29, 1911.
Rhus copallina L. September 7, 1911.

CYRILLACEÆ

Cyrilla racemiflora L. May 24, 1912.

AQUIFOLIACEÆ

Ilex opaca Ait. May 24, 1912.
Ilex glabra L. May 30. 1913.

CELASTRACEÆ

Euonymus americanus L. September 7, 1911; May 6, 1912; May 12, 1914.

ACERACEÆ

Acer rubrum L. April 24, 1912.

BALSAMINACEÆ

Impatiens biflora Walt. May 24, 1913.

RHAMNACEÆ

Rhamnus lanceolata Pursh. June 25, 1915.
Ceanothus americanus L. May 24, 1913; May 22, 1911

VITACEÆ

Vitis rotundifolia Michx. May 22, 1911.

MALVACEÆ

Sida rhombifolia L. July 15, 1913.
Hibiscus moscheutos L. August 1, 1913.

HYPERICACEÆ

Hypericum fasciculatum Lam. July 15, 1913.
Hypericum mutilum L. July 31, 1915.

CISTACEÆ

Lechea villosa Ell. July 15, 1913; July 31, 1915.

VIOLACEÆ

Viola papilionaceae Pursh. April 16, 1911.
Viola cucullata Ait. April 21, 1912.
Viola emarginata LeConte. April 24, 1912.
Viola primulifolia L. May 6, 1912.
Viola palmata dilatata Ell. July 24, 1913.
Viola sp. nov. (?) April 20, 1914. Dr. E. L. Greene stated in determining the species that it is a "Near ally of *V. cucullata;* not identical with it by any means; but as a variety or as a subspecies it is nameless."

PASSIFLORACEÆ

Passiflora incarnata L. July 15. 1911.

MELASTOMACEÆ

Rhexia mariana L. June 25, 1915.
Rhexia virginica L. August 20, 1913.

ONAGRACEÆ

Ludwigia alternifolia L. September 7, 1911.
Epilobium sp. July 31, 1915.
Oenothera laciniata Hill. April 28, 1911.
Oenothera speciosa Nutt. May 6, 1912.
Kneiffia linearis Michx. May 11, 1912; May 13, 1913; May 30, 1913; May 12, 1914.
Kneiffia longipedicellata Small. May 23, 1911; June 25, 1915.

UMBELLIFERÆ

Sanicula marylandica L. July 31, 1915.
Sanicula canadensis L. May 24, 1913.
Sanicula sp. June 7, 1915.

Hydrocotyle umbellata L. June 15, 1913.
Chaerophyllum floridanum Coult. & Rose. April 15, 1915
Apiastrum patens (Nutt.) C. & R. May 24, 1913.
Ptilimnium capillaceum (Michx.) Holl. July 31, 1915; June 15, 1912.
Zizia cordata (Walt.) DC. Steedman, S. C. May 30, 1913.
Cerefolium cerefolium (L.) Britt. May 6, 1914.
Angelica villosa (Walt.) BSP. July 31, 1915.
Daucus carota L. July 15, 1911.
Daucus pusillus Michx. May 24, 1912.

CORNACEÆ

Cornus florida L. April 29, 1911; April 21, 1912; April 24, 1912.
Nyssa sylvatica Marsh. August 11, 1913; May 6, 1912; also Steedman, S. C., May 16. 1914.

ERICACEÆ

Chimaphila maculata (L.) Pursh. May 24, 1911.
Azalea viscosa L. May 30, 1913.
Azalea nudiflora L. May 22, 1911; April 15. 1912.
Kalmia latifolia L. May 16, 1914.
Pieris floribunda B. & H. July 31, 1915.
Pieris mariana (L.) B. & H.
Oxydendrum arboreum (L.) DC. June 2, 1913.
Vaccinium atrococcum (Gray) Heller. April 24, 1912.
Vaccinium caesium Greene. April 16, 1911.

PRIMULACEÆ

Samolus floribundus H. B. K. May 11, 1912; June 20, 1914.

STYRACACEÆ

Styrax americana Lam. May 6, 1912.

OLEACEÆ

Chionanthus virginica L. July 31, 1915

LOGANIACEÆ

Cynoctonum sessilifolium (Walt.) J. F. Gmel. August 1, 1913.
Polypremum procumbens L. August 1, 1913; June 25, 1915.

APOCYNACEÆ

Apocynum cannabinum L.

ASCLEPIADACEÆ

Asclepias variegata L. May 22, 1911; May 13, 1913.
Asclepias tuberosa L. May 24, 1913; May 30, 1913.

CONVOLVULACEÆ

Quamoclit coccinea (L.) Moench. August 20, 1913.
Ipomoea purpurea (L.) Roth. November 1, 1915.
Ipomcea pandurata L. July 15, 1911.
Cuscuta arvensis Beyr. August 1, 1913.

POLEMONIACEÆ

Pholox amoena Sims. May 30, 1913.
Phlox maculata candida Michx. July 15, 1911.
Phlox maculata L. May 30, 1913.

BORAGINACEÆ

Lithospermum Gmelinii (Michx.) A. S. Hitch. May 30, 1913; also Steedman, S. C. May 16, 1914.
Onosmodium virginianum (L.) DC. May 16, 1914.

VERBENACEÆ

Verbena urticaefolia L. June 17, 1913.
Callicarpa americana L. August 1, 1913.

LABIATEÆ

Scutellaria pilosa Michx. May 30, 1913.
Scutellaria integrifolia L. May 14, 1913; May 16, 1914; June 25, 1915.
Scutellaria montana Chapm. May 7, 1915.
Prunella vulgaris L. May 22, 1911; May 11, 1912.
Stachys arvensis L. June 25, 1915.
Salvia lyrata L. April 21, 1912; May 24, 1913; April 29, 1911; June 25, 1915; May 16, 1914.
Salvia azurea Lam. October 10, 1914.
Kcellia flexuosa (Walt.) Mac M. June 25, 1915.
Koellia hyssopifolia Michx. June 25, 1915.
Mentha spicata L. September 30, 1914.
Mesosphaerum rugosum (L.) Pollard. August 1, 1913.

SOLANACEÆ

Solanum carolinense L. May 24, 1912.
Solanum nigrum L. July 31, 1915.
Datura stramonium L. August 12, 1915.

SCROPHULARIACEÆ

Verbascum Thapsus L. July 31, 1915.
Linaria canadensis (L.) Dumort. April 20, 1914; April 18, 1911.
Pentstemon hirsutus (L.) Wild. May 16, 1914.
Pentstemon canescens Britt. May 6, 1912.
Pentstemon sp. May 24, 1913.
Mimulus alatus Soland. August 20, 1913.
Digitalis purpurea L. June 28, 1914.
Gratiola aurea Muhl. June 15, 1913.
Dasystoma flava L. July 31, 1915.
Dasystoma pectinata Nutt. July 16, 1915

LENTIBULARIACEÆ

Utricularia purpurea Walt. May 30, 1913.
Utricularia vulgaris L. May 16, 1914.

BIGNONIACEÆ

Tecoma radicans (L.) Juss. July 15, 1911; July 31, 1915.

ACANTHACEÆ

Ruellia hybrida Pursh. July 15, 1914.

PLANTAGINACEÆ

Plantago heterophylla Nutt. April 15, 1914.
Plantago virginica L. May 6, 1912; April 15, 1914.
Plantago aristata Michx. July 15, 1911.
Plantago lanceolata L. August 12, 1915.

RUBIACEÆ

Galium hispidulum Michx. June 25, 1915.
Galium Claytonii Michx. June 15, 1912.
Galium tinctorium filifolium Wiegand. June 20, 1914.
Galium pilosum Ait. August 20, 1913.
Galium triflorum Michx. May 11, 1912.
Diodia teres Walt. October 30, 1915; August 1, 1913.
Mitchella repens L. September 20, 1911; May 11, 1912; August 20, 1913.
Cephalanthus occidentalis L. May 24, 1912.
Houstonia ciliolata Torr. April 18, 1911.
Houstonia serpyllifolia Michx. April 21, 1912.
Houstonia coerulea L. April 15, 1914.

CAPRIFOLIACEÆ

Lonicera japonica Thunb. June 25, 1915.
Lonicera sempervirens L. April 29, 1911; April 24, 1912.
Symphoricarpos orbiculatus Moench. June 25, 1915.
Linnaea borealis L. May 11, 1912.
Viburnum rufidulum Raf. April 29, 1911.
Viburnum prunifolium L. July 15, 1913.
Sambucus canadensis L. July 15, 1911; May 24, 1912.

CAMPANULACEÆ

Specularia perfoliata (L.) A. DC. April 18, 1911; May 6, 1912.

LOBELIACEÆ

Lobelia syphilitica L. September 20, 1911; August 20, 1913.
Lobelia cardinalis L. September 7, 1911; July 15, 1913; August 20, 1913.

COMPOSITEÆ

Vernonia noveboracensis (L.) Willd. August 1, 1913.
Vernonia angustifolia Michx. July 15, 1913.
Elephantopus tomentosus L. September 7, 1911; August 20, 1913.
Eupatorium aromaticum L. September 20, 1911; October 10, 1914.
Eupatorium hyssopifolium L. September 7, 1911; August 20, 1913.
Eupatorium purpureum L. July 31, 1915.
Eupatorium capillifolium (Lam.) Small. October 10, 1914.
Mikania scandens (L.) Willd. August 1, 1913.
Chrysopsis graminifolia (Michx.) Nutt. September 7, 1911; March 13, 1914; July 31, 1915.
Chrysopsis mariana L. September 20, 1911.
Solidago odora Ait. Fall of 1913.
Solidago petiolaris Ait. October 10, 1914.
Solidago brachyphylla Chapm. October 10, 1914.
Euthamia tenuifolia Nutt. July 31, 1915.
Aster infirmus Michx. August 20, 1913.
Aster linariifolius L. October 10, 1914.
Aster concolor L. October 10, 1914.
Aster patens Ait. October 10, 1914.
Aster lateriflorus (L.) Britt. October 10, 1914.
Isopappus divaricatus (Nutt.) T. & G. August 20, 1913.
Erigeron canadensis L. August 1, 1913.
Erigeron ramosus (Walt.) BSP. May 22, 1911; August 1, 1913; May 12, 1914.
Erigeron quercifolius Lam. April 16, 1911.
Sericocarpus linifolius (L.) BSP. July 15, 1913.
Sericocarpus asteroides (L.) BSP. July 15, 1913.

Baccharis halimifolia L. November 10, 1913.
Gnaphalium purpureum L. July 15, 1913.
Gnaphalium spathulatum Lam. April 21, 1914.
Gnaphalium sp. July 15, 1911.
Silphium asteriscus L. September 7, 1911; May 24, 1913; July 15, 1913.
Silphium compositum Michx. July 15, 1913.
Chrysogonum virginianum L. April 18, 1911; April 24, 1912.
Ambrosia artemisifolia L. September 30, 1914.
Xanthium canadense Mill. September 30, 1914.
Eclipta alba (L.) Hassk. October 10, 1914.
Rudbeckia laciniata L. May 22, 1911; September 20, 1911.
Rudbeckia amplectens T. V. Moore. July 31, 1915.
Helianthus astericus. June 25, 1915.
Helianthus anuus L. June 10, 1915.
Helianthus atrorubens L. September 20, 1911.
Coreopsis major Walt. May 22, 1911.
Coreopsis lanceolata villosa Michx. April 18, 1911.
Coreopsis delphinifolia Lam. June 25, 1915.
Marshallia obovata (Walt.) B. & B. June 20, 1914.
Helenium tenuifolium Nutt. July 15, 1911.
Achillea millefolium L. August 12, 1915.
Anthemis cotula L.
Chrysanthemum leucanthemum L. August 14, 1915.
Senecio balsamitae Muhl. April 18, 1911.
Carduus spinosissimus Elliottii (T. & G.) Parker. May 24, 1913.
Carduus Lecontei (T. & G.) Pollard. June 25, 1915.
Cirsium discolor (Muhl.) Spreng. June 15, 1912.
Krigia virginica (L.) Willd. May 6, 1912.
Sonchus asper (L.) Hill. May 6, 1914.
Hieracium venosum L. April 21, 1912.
Willughbya scandens (L.) Ktze. September 7, 1911.
Facelis apiculata Cass. June 30, 1914.

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THE RUSSULAS OF NORTH CAROLINA*

By H. C. Beardslee

Plants solitary or gregarious, regular, rigid, but fragile from the structure of the flesh which in the cap is composed of large spherical cells, and not filaments, thus agreeing with Lactarius. Cap convex, plane, or depressed in center, exhibiting a great variety of colors, many of which are quite conspicuous, such as red, yellow, green, blue, pink, etc. Gills attached, rigid, but quite fragile. Stem central, rigid. Veil absent. Spores usually globose, white, creamy, or yellow.

The genus Russula is represented in North Carolina by numerous species which occur in large numbers through the summer. Many of these are conspicuous on account of their bright color and comparatively large size. The following notes have been prepared in the hope that they may be of assistance to those of the state who become interested in this attractive group. It will be understood that the work on this genus is far from being complete. A number of our species are not clearly defined, and there is much disagreement in regard to them in Europe. Our American species cannot be finally disposed of until some of this doubt is cleared away. It is hoped that the results of several years of work on this difficult genus may be of assistance to others, and help to bring about a better knowledge of the Russulas of our state.

In studying the Russulas it is of great importance to secure a good spore print. A mature cap should be placed on white paper over night,

*In our series of studies of the fleshy fungi of North Carolina, the treatment of this genus has been undertaken by Mr. H. C. Beardslee of Asheville, who has paid special attention to the Russulas for many years. All descriptions and remarks are by him except where otherwise indicated, the notes by me being selected by him from among those sent him. All numbers and all notes and remarks by me refer to our Chapel Hill collections. The origin of the photographs is indicated in each case.—W. C. Coker, Editor.

and, if the specimen is a good one, a mass of spores will be deposited whose color will be distinct. The colors of the spore masses are very constant so that the species can be divided into fairly sharply defined groups on the basis of their spore colors. In addition, some species will be found to be peppery or acrid in taste, while others are mild. Using these characters as the basis of division, I have made six groups which it is hoped the beginner will find definite enough to enable him to place his species with fair accuracy.

Group I includes the species in which the spores are pure white with no trace of cream color, and the taste is mild. Group II includes the white spored species whose taste is acrid. Group III includes the species whose spores show any trace of cream and are not darker than a distinct cream color (about maize yellow of Ridgway's key, or about the color of the spores of *R. flavida,* which is quickly recognized), and whose taste is mild. Group IV has the same spore color and the taste acrid. Groups V and VI include the species whose spores are darker than maize yellow, and are mild and acrid respectively. It is hoped that these will be found fairly easy of determination, though it is too much to hope that species will always be easy to identify.

Those who are fortunate enough to have the use of proper lenses will also find that, contrary to the usual belief, very valuable information can be obtained by a careful microscopic examination of the spores. For this purpose a good 1/12 in. oil immersion objective is required. With such an objective of good quality, it will be found that the spore markings separate the spores into three classes. One series of species have the spores nearly smooth. They seem, with a low power, to be entirely smooth; but, with higher powers, are seen to be marked with faint warts and lines. A second series have the surface set with more or less prominent spines. In this series the character of the spines is quite constant in each species, some having the spines fine and closely set, while others are coarse and scattering. A third series have the surface marked with raised lines which usually unite in a reticulation. While some information can be obtained from an objective of ordinary power, an objective of higher power and good quality will

be found to furnish very precise, determinative information. *Russula meliolens*, for example, appears in many disguises. Under a powerful magnification the large globose spores, which are nearly smooth, at once identify it.

In our literature these characters have been largely ignored. The spore of *R. fœtans* is, for example, always spoken of as "coarsely tuberculate"; while the truth is, its spores are marked with distinct reticulating lines. These characters have been found so useful that a painstaking attempt has been made to accurately describe each spore as it appears when highly magnified.

The drawings of the spores of twenty-nine species of Russula which appear in plate 112 have been copied from drawings made during the past three years. In every case a large number of spores from different specimens have been examined and a characteristic drawing has been selected. I am entirely aware that the spore surface as it is here shown is not in accord with the usual description of several of the species represented. It is probable that in some cases I have not correctly represented the spore characters. To accurately fix the limits of variation, specimens from different locations must be examined in large numbers. This has not been done as yet. In some cases, also, there is disagreement in regard to species. In addition it may be said that accurate work is laborious and requires good conditions of light and appliances. Those who are interested to test the matter carefully will find that their oil immersions will give them valuable assistance in their work.

Mistakes have doubtless been made, but it is hoped that this contribution to the study of this very difficult genus will be found of value.

Important American Literature:

Peck N. Y. State Cab. Rep. **23**:120. 1872.
Peck N. Y. State Mus. Bull. **116**:67. 1907.
McAdam. Jour. of Mycology **5**:58. 1889.
Beardslee. Mycologia **6**:88. 1914.
Kauffman. Mich. Acad. of Sci. Rep. **11**:57. 1909.
Burlingham. North American Flora **9**:201. 1915

KEY TO THE SPECIES*

Spores pure white, like chalk; taste mild........................Group I
Spores pure white, like chalk; taste acrid........................Group II
Spores creamy white to cream color; taste mild................Group III
Spores creamy white to cream; taste acrid........................Group IV
Spores deep cream to ochraceous; taste mild......................Group V
Spores deep cream to ochraceous; taste acrid......................Group VI

GROUP I. SPORES PURE WHITE; TASTE MILD

Cap persistently white ....*R. delica.* (1)
Cap some shade of red.............................1
Cap green or purple...............................*R. variata* (2)
Cap not as above..................................2
1. Stem white or reddish..........................*R. uncialis* (3)
1. Stem deep red..................................*R. purpurina* (4)
2. Flesh becoming black when wounded, and in drying ....*R. adusta* (5)
2. Flesh becoming red, then black when wounded...3
2. Not as above...................................4
3. Gills thin crowded.............................*R. densifolia* (10)
3. Gills thicker, subdistant to distant...............*R. nigricans* (11)
4. Color dull bay.................................*R. compacta* (6)
4. Color yellowish-straw translucent.................*R. Earlei* (8)
4. Color yellow or cream, not translucent............*R. flava* (16)
4. Cap pale, with numerous small, appressed scales...*R. floccosa* (9)

GROUP II. SPORES PURE WHITE; TASTE ACRID

Cap some shade of red.............................1
Cap at first white or whitish.......................2
Cap some shade of green or purple..................*R. variata* (2)
Cap yellowish ....*R. ochroleuca* (12)
Cap yellowish straw color, tough, translucent.........*R. Earlei* (8)
1. Gills rather distant, nearly free..................*R. emetica* (13)
1. Gills close, adnexed............................*R. fragilis* (14)
2. Flesh becoming black when wounded..............*R. adusta* (5)
2. Flesh becoming rusty-ochraceous when wounded..*R. compacta* (6)
2. Flesh becoming brick-red when wounded.........*R. magnifica* (7)

*Figures in parenthesis refer to the species number. In addition to some of the species described here, Curtis also lists from Schweinitz *R. lactea* Fr., *R. substiptica* Fr., *R. nitida* Fr., and *R. ochracea* Fr. The plants so determined are probably included by us under other names. His *R. depallens* and *R. lutea* Fr., we have entered with a question under *R. decolorans* and *R. flavida*.—COKER.

GROUP III. Spores Creamy White to Cream; Taste Mild

Stem becoming red, then black, when wounded......*R. cinerascens* (15)
Not as above..................................1
1. Cap white or nearly so, taste slightly bitterish....*R. albida* (16)
1. Cap yellow or cream color, taste quite mild.......2
1. Cap some shade of red.........................3
1. Cap purplish or vinaceous.....................5
1. Not as above..................................6
2. Stem white ....*R. flava* (17)
2. Stem yellow ....*R. flavida* (18)
3. Stem becoming cinereous with age..............*R. decolorans* (19)
3. Not as above..................................4
4. Small, cap 2-4 (rarely 5) cm. broad...........*R. pusilla* (20)
4. Larger, strong odor of new meal in drying........*R. meliolens* (21)
5. Cap distinctly pruinose ....*R. Mariae* (22)
5. Cap not distinctly pruinose.....................*R. cyanoxantha* (23)
6. Cap greenish, with appressed scales, margin nearly even ....*R. virescens* (24)
6. Cap with margin distinctly striate...............*R. crustosa* (25)

GROUP IV. Spores Creamy White to Cream; Taste Acrid

Cap white ....*R. albidula* (26)
Cap red 1
Cap not as above................................2
1. Taste very acrid................................*R. sanguinea* (27)
1. Taste slightly acrid............................*R. lepida* (28)
2. Cap large, sordid-yellowish or ochraceous.........*R. fœtans* (29)
2. Smaller, cap brown or gray......................*R. pectinata* (30)
2. Smaller, cap conspicuously granular..............*R. pulverulenta* (31)

GROUP V. Spores Deep Cream to Ochraceous; Taste Mild

Stem becoming red, then black, when wounded......1
Stem becoming yellow when wounded...............2
Stem white, yellow or orange at the base............*R. luteobasis* (32)
Not as above....................................3
1. Cap red ....*R. rubescens* (33)
1. Cap cream color ....*R. magna* (34)
2. Odor in drying strong and disagreeable...........*R. xerampelina* (35)
2. Not as above...................................*R. puellaris* (36)
3. Cap dingy white, straw color or greenish; spores light yellow 4
3. Cap some shade of red or purple..................5
3. Cap with distinct shades of golden yellow.........*R. aurata* (37)

4. Cap dingy white, or shaded with yellow or reddish yellow ....*R. basifurcata* (38)
4. Cap dingy straw color..........................*R. grisea* (39)
4. Cap olivaceous green ....*R. olivascens* (40)
4. Cap grass green ....*R. graminicolor* (41)
5. Cap distinctly velvety ....*R. subvelutina* (42)
5. Cap purple to purple-brown; odor with age disagreeable ....*R. nauseosa* (43)
5. Cap red or purple-red, spores deep ochraceous.....6
6. Spores reticulated ....*R. Romellii* (44)
6. Spores spinulose ....*R. alutacea* (45)

GROUP VI. SPORES DEEP CREAM TO OCHRACEOUS; TASTE ACRID

Cap orange, fading to orange or yellow..............*R. aurantialutea* (46)
Cap not as above...................................1
1. Stem becoming red when wounded...............*R. tenuiceps* (46)
1. Stem not becoming red when wounded............*R. pungens* (47)

1. **Russula delica** Fr.

PLATES 70 AND 111.

Cap firm, white. 7.5-12.5 cm. broad, soon depressed and infundibuliform, dull and opaque in appearance, more or less marked with rusty spots.

Gills rather crowded, white or slightly rusty, often forking, with some shorter, adnate, decurrent; taste mild, or slightly acrid.

Stem short, firm, colored like the cap.

Spores subglobose, 7-9μ long, spinulose.

In woods, not rare, Asheville.

Asheville specimens of this species seem to vary. I find occasional specimens which could possibly be referred to *R. chloroides* as Bresadola describes it. I am unable to satisfy myself, however, that we have more than one species.

Notes by Coker follow:

This is a peculiar plant, often imperfect and aborted, that is not rare in lawns and groves. Cap rarely expanded, usually failing to get entirely out of the ground, nearly always extremely irregular, roughly hemispheric until nearly grown, then expanding and cracking and rough; very often the margin of the cap remaining attached to the ground, and the cap splitting into three or four pieces which break

from the short stem and form a disordered mass; surface white or sordid white, tomentose to smoothish, and much obscured by earth particles, the margin hardly more than minutely velvety. Flesh white, about 4-8 mm. thick near stem, firm and hard, not changing, or brownish in old wounds, a very disagreeable fishy taste at first, then sharply peppery.

Gills light sea-green when young, becoming nearly pure white at maturity, sordid-ochraceous on old wounds, adnexed, moderately close, none forked, veined at stem and often with cross partitions, sometimes dedalioid near the margin, 3-5 mm. wide, secreting clear drops when young.

Stem short, about 3 cm. long, and 1.9-2.8 cm. thick, glabrous, rugulose, firm and usually solid, sometimes cavernous, the base not coming free, but diffused into the earth with the mycelium.

Spores (of No. 2188) pure white, subspherical, spinulose, 7-9 x 9-10.5μ.

These plants are suspiciously like a Lactarius, though without milk. It is described by others as having a mild or only slightly acrid taste. It may be that ours is *R. chloroides* Bresadola. In all our plants the gills are distinctly sea-green when young.

2188. Under oaks in Mrs. Kluttz' lawn, June 21, 1916. Photo.

2211. In Dr. Wheeler's lawn, June 23, 1916.

2216. Under oaks, lawn of "The Rocks," June 24, 1916.

2544. In path in mixed pine and oak woods back of athletic field, June 22, 1917.

The illustration in Mycologia 8: No. 3, Pl. 183, fig. 1, is of a form much darker than our plants.

2. **Russula variata** Banning.

PLATES 72 AND 111.

Cap 6-10 cm. broad, firm, convex, soon becoming depressed and infundibuliform, colored with a peculiar mixture of olive green, purple and gray, usually darker and more olive at the center, and lighter and more purple at the margin; surface dull and opaque, usually marked with delicate wrinkles which form a reticulate network. Margin thin, even or nearly so; flesh firm, becoming thin at the margin; taste slowly acrid.

Gills crowded, white, much forked, at first very narrow, becoming broader with maturity, decurrent.

Stem white, firm, cylindrical, pruinose at top.

Spores pure white, delicately warted, subglobose, 6-6.5 x 7-8μ long.

This species is very abundant in our woods; possibly it is our most abundant species. The peculiar combination of its colors and its narrow, forking lamellæ distinguish it. It is, however, a problematic species, in my opinion. It has been closely observed at Asheville, and it seems clear that we have only this species in the group. I find old specimens which have lost their acridity, and have lost also most of their purple color. In these plants the lamellæ are broader, and they might well be referred to a different species. They are, however, certainly only an older form of the same plant. *Russula furcata*, to which this species is related, seems to be also problematic. Romell, whose thorough knowledge of the Swedish Russulas is well known, writes me that he has never seen it in Sweden. Maire says it is much misunderstood in Europe. Peck says he has found it in one limited locality. I have seen nothing that can be referred to it at Asheville. It seems best to use for our plant Banning's name, though it seems probable that when the European species are satisfactorily defined we shall find that our plant is not unknown in Europe.

Notes by Coker follow:

Color very variable and with peculiar shades, usually dull olivaceous with tint of purple in center, shading to light pallid purplish towards margin, varying from this to pale purplish or purplish green or greenish; sometimes with rather distinct zonations of color. Flesh quite mild or moderately acrid, varying in this respect at all ages, usually grayish in age.

Gills much forked or almost none forked, very variable in this respect, and also in color when bruised, which may become scorched or may not change. A very common plant in woods and groves.

1569. Battle's Park, June 21, 1915.

2077. Shaded lawns of the old Mangum Place, June 12, 1916. Spores chalk white, minutely tuberculate, 5.5-7.4μ.

2099. Dr. Lawson's lawn, June 14, 1916. Spores chalk white, spherical, minutely tuberculate, 5.9-7.4μ.
2137. Grove by Gimghoul Lodge, June 18, 1916.
2172. Battle's Grove, June 20, 1916.
2217. Lawn of "The Rocks," June 24, 1916.
2262. Oak woods at top of Lone Pine Hill, June 27, 1916.

Middle district (Schw. as *R. furcata?*), woods and thickets. Curtis.

3. **Russula uncialis** Pk.

PLATE 111.

Cap 1.3-7.5 cm. broad, soon becoming plane, viscid when moist, red or pinkish red, minutely granulose, striate on the margin; flesh thin, white; taste mild.

Gills white, narrowed toward the stem, moderately close, usually red on the margin on the outer third.

Stem white or colored like the cap, but lighter; pruinose at the top, stuffed or spongy within.

Spores pure white, broadly ellipsoid, 7-9μ long, marked with more or less elongated warts.

In lawns under trees, common, Asheville.

The color of this attractive species is different in quality from that of *R. fragilis*. It is distinctly a pink red. It occurs with us in lawns and along paths in the woods. I find it quite variable and often exceeding the dimensions given by Peck. One form which occurs in lawns seems almost distinct. It has a longer stem than is typical, which is distinctly red. The mild taste, delicately pruinose cap, and pure white spores easily distinguish it.

Notes by Coker follow:

Cap 3.5-6.5 cm. broad, depressed in center, margin distinctly striate, surface pruinose, granulose, sometimes almost pubescent in center, and in some cases (No. 1667) strongly tuberculate in center; color a dull rosy red, almost Corinthian red of Ridgeway, somewhat darkest in center; cuticle easily removable, viscid when moist; flesh white, soft, thin, not very fragile, tasteless.

Gills adnexed, all of equal length, about 4 mm. wide at the wide marginal end; white, then pallid cream, interveined.

Stem 3.5-5 cm. long, about 7-13 mm. thick at top, enlarged or somewhat smaller below, smooth, usually white below, rosy elsewhere but not with granules, stuffed or cavernous inside.

Spores (of No. 1667) pure white, subspherical, moderately tuberculate, 6-7.2μ. Gill margin set with numerous, abruptly apiculate cystidia.

1667. In low woods near Howell's branch, July 28, 1915.
2315. Battle's Grove (oaks), June 30, 1916. Spores about 7 x 8μ.
2517. Dry oak woods east of cemetery, June 14, 1917. Gills interveined; spores subspherical to oval, warted, pure white, 6.6-7.4 x 7.4-8.2μ.

4. **Russula purpurina** Q. & S.

Cap deep red, 5-10 cm. broad, convex then plane, at first even on the margin, then somewhat striate, cuticle separable, fragile, flesh white, reddish under the cuticle; taste mild.

Gills thin, moderately close, white, becoming slightly yellowish, usually pink and flocculose on the margins.

Stem colored like the cap, but often lighter, spongy within, nearly equal.

Spores broadly ellipsoid, 7-9μ, marked with elongated warts.

In woods, rare, Asheville.

This is a larger and more deeply colored plant than *R. uncialis.* It has been detected only a few times at Asheville, and has not been thoroughly studied. It seems, however, the same plant that has been reported farther north.

5. **Russula adusta** (Pers.) Fr.

PLATES 73 AND 111.

Cap 7.5-15 cm. broad, white, becoming sooty-gray, and then blackish with age and in drying; flesh firm, white, becoming black when wounded; margin even, thin. The gills have an acrid taste, otherwise the flesh is mild.

Gills thin, crowded, adnate, nearly equal, blackening when wounded.

Stem solid, firm, white, blackening when wounded.

Spores subglobose, 7-9μ, warted.

This is usually referred to *R. sordida* Pk. It is, however, the same plant which we collected in Sweden with Romell as *R. adusta*. Maire states that the flesh of *R. adusta* becomes black at once when it is broken, and Romell, whose thorough knowledge of the Swedish Russulas is well known, so understands it. Carleton Rea, the eminent English authority, states in a letter that "*R. adusta* is characterized by its narrow, moderately crowded lamellæ, and its white flesh which turns to black when broken." His figures, which I have examined and discussed with him, agree with our plant. I have preferred to follow these authorities in spite of the difficulties of the description.

Asheville. Beardslee.

Middle district (Schw.), woods and thickets. Curtis.

5*a*. **Russula adusta** (Pers.) Fr. Form with unchanging flesh.

Coker's description of a Chapel Hill form with unchanging flesh is as follows:

Very large and stout plants of dull color. Cap up to 14 cm. broad, not zoned, depressed in center, lightly roughened and wrinkled with areolations and frequently with cracks. Color a smoky tan to snuff-brown. Flesh grayish-white, soft and fragile, about 8-9 mm. thick half way to margin, not becoming black when wounded.

Gills nearly white when young, passing through a creamy flesh color to a much deeper flesh-tan with a touch of lavender, distant, none forked, many very short ones at margin, very fragile, squarely attached or slightly rounded at the stem, about 1 cm. wide at the deepest point, which is beyond center.

Stem very large, tapering downward, about 6-7 cm. long and 3-3.7 cm. thick. Flesh like that of the cap, solid, but soft and fragile; surface smooth, about color of cap except the nearly white base.

Spores white, spherical, roughened, with one large oil drop; 7.4μ in diameter.

It is probable that the change of flesh color in *R. adusta* when wounded may not be a constant character and that this is really the same as the above.

1146. Sphagnum moss bed east of athletic field, July 18, 1914.

6. **Russula compacta** Frost.

PLATE 74.

Cap 7-15 cm. broad, at first convex, with the margin incurved, at length expanded and depressed at the center, at first white or whitish, becoming pale tawny, dry and opaque, the cuticle with a texture like kid. Flesh white, firm, becoming brown when cut, about 10 mm. thick near the stem, thinner towards the margin; taste in my specimens mild, odor very faint, but becoming disagreeable in drying.

Gills rather close, narrow, about 8 mm. broad at the broadest point, much narrower toward the stem, creamy white, becoming brown when injured and in drying, adnate.

Stem spongy stuffed, white at first, changing color like the gills, 2-3 cm. thick, 4-7 cm. long.

Spores white, globose, 7-9μ broad, appearing nearly smooth under a 1/5 objective, with higher magnification clearly warted.

This species has been found only twice at Asheville. My specimens were entirely mild in taste, though it is said to be at times slightly acrid. The peculiar brown color of the gills and to a less extent of the cap and stem in drying is characteristic. It will probably be found throughout the state.

Notes by Coker follow:

Low, stout, heavy plants, gregarious or cespitose in low mossy woods. Cap up to 11 cm. broad, not zoned, depressed in center, the margin strongly bent down, and remaining so until late, fully expanded only at full maturity. Surface smooth and dull bay color all over except for lighter areas where covered over with leaves or trash; texture of leather and often cracked near the margin. Flesh white, firm, turning light brown when cut, about 4-6 mm. thick half way to margin; taste mild. The plant is said to develop a somewhat disagreeable odor on drying, though it has no distinctive smell when fresh.

Gills crowded, narrow, broadest near margin, where they reach 2.5-5 mm., squarely attached to stem, white or pallid, turning a deep scorched brown when bruised and deepening to this color in age.

Stem short and stout, solid, but often badly riddled by grubs, 3-4

cm. long and 1.5-2 cm. thick; surface pruinose, smooth, pure white except that the base is usually discolored by contacts to the shade of the cap.

Spores white, spherical, rough, a large oil drop, varying considerably in size in the same plant, 6.8-9.2μ, mostly about 7.5μ in diameter.

This species is new to the south, being reported by Miss Burlingham only from New England, New York, and New Jersey.

1134. Low woods at foot of Lone Pine Hill, July 13, 1914. Photo. Spores 7-9.2μ in diameter.

1163. In hollow below sphagnum moss bed east of athletic field, July 20, 1914. Spores 6.6-8μ in diameter.

2316. Damp woods at foot of Lone Pine Hill, June 28, 1916.

2319. Mossy soil, Battle's Grove (oaks), June 30, 1916. Photo.

2557. Battle's Grove (oak), June 22, 1917.

Beaufort, abundant. Beardslee.

7. **Russula magnifica** Pk.

This has been found only in Chapel Hill and the following is by Coker:

Cap up to 13 cm. broad, rounded and umbilicate when young, deeply infundibuliform in age, smooth, not shining, pure white when quite young and untouched, but soon with shades of fleshy-buff, or brick and deeper buff when older; surface when young scurfy-coated, the scurf soon cracking up, easily rubbed off, and thus disappearing entirely at times.. Beneath the scurf is a very distinct surface layer that can be easily peeled off. Flesh dry, firm, brittle, mild, but with a peculiar, rather disagreeable, flat earthy taste, from 0.9-1.3 cm. thick in center, turning quickly a clear brick red on the surface and next the gills when bruised, after maturity more slowly changing.

Gills crowded, many short ones of various lengths, unbranched, squarely attached in youth, apparently decurrent later from the shape of the cap, light fleshy-cream when young, deep brick red when old and on drying, turning reddish when bruised, 3.5-6 mm. deep in center.

Stem short or moderately long, 3.5-9 cm. long, tapering or almost equal, about 2 cm. thick in center, smooth, dull, stained usually like the cap below, white above, becoming colored all over in age, solid

but soon riddled by grubs; flesh turning pink near the surface after a time when cut.

Spores (of No. 873) white, spherical to elliptic, minutely roughened, 5.5-7 x 5.5-11μ.

A large plant with the general appearance of *Lactarius piperatus* but without milk. It is not rare in mixed woods from late June to October. The occurrence of this fine species here is interesting as it has been known before only from the type locality at Port Jefferson, New York. There can be no doubt that our plant is this species, as it agrees in all important respects with the type and the spores are identical (compared by Beardslee).

Illustrations: Bull. N. Y. St. Mu. **67**, Pl. N.

873. Battle's Park, in dry woods behind Dr. Wheeler's, scattered and solitary, October 3, 1913. Photo.
901. Battle's Park, north of the cemetery, October 7, 1913.
2326. By Meeting of the Waters branch, damp soil, June, 1916. Spores white, spherical to elliptic, minutely roughened, 5-7 x 6-10μ.
2375. Mixed upland woods near Piney Prospect, July 8, 1916.

8. **Russula Earlei** Pk.

PLATE 75.

This has been found only in Chapel Hill, and the following is by Coker:

Cap up to 7 cm. in diameter, a light yellowish straw color, with a translucent watery appearance, depressed in center with margin rounded and not at all striate, edge of young plants inrolled; surface viscid, smooth except for small blisters in places, the embedded eggs of an insect. Flesh white, unchanging, pithy, about 1 cm. thick, mild (as in No. 2765) or slowly and moderately peppery (No. 2292), toughish and firm, not easily breaking, but formed of vesicular cells.

Gills watery white, becoming light creamy flesh color, distant, thick, many short ones and a few forked, about 3-9 mm. wide in center, narrowing at both ends, turning sordid when bruised. Basidia four-spored, sterigmata about 5μ long.

Stem up to 5 cm. long and 2 cm. in diameter, tapering towards the base, white, solid, but somewhat pithy, turning dark only in a line along the surface of the ground.

Spores pure white, short elliptic, minutely tuberculate, 3.7 x 4.4-5.5μ.

Remarkable for the watery, translucent appearance when fresh. Except for the absence of milk this plant looks much more like a Lactarius than a Russula. The gills undergo a change of color in drying just as in many species of Lactarius, and the general appearance is that of a Lactarius. However, in respect to tradition and for convenience I refer this to *R. Earlei* with which it seems to agree well except that there is no mention in the description of that species of a peppery taste at times, a somewhat variable quality in Russula. The species is easily separated from others by the distant gills, small spores and tough flesh. It has been reported heretofore only from Long Island.

2292. Damp shaded woods by Howell's branch, north of Dr. Henderson's, June 28, 1916. Photo.

2337. Deciduous woods by path along Battle's branch, just east of Dr. Battle's, July 1, 1916.

2765. Low woods near ditch north of cemetery, July 24, 1917. Taste mild; gills about 9 mm. wide in older plants.

9. **Russula floccosa** Buri.

PLATE 111.

Cap rather thin, pale, sprinkled with adnate granules which have a vinaceous color, becoming striate on the margin.

Gills thin, crowded, equal white.

Stem colored like the pileus, stuffed then hollow, glabrous.

Spores white or creamy white, almost globose, 6.5 to 7.5, nearly smooth.

Only one specimen of this species was found. The cap is almost creamy white in this, but the numerous vinaceous granules give it a purplish color. It seems quite distinct. My spore print was not decisive. The color seemed white, but whether with a tint of cream could not be ascertained.

10. **Russula densifolia** Secr.

Cap 5-10 cm. broad, convex then depressed, at first white or nearly so, becoming gray or smoky brown with age; flesh firm, white, becoming red then black when broken.

Gills thin, rather crowded, adnate or decurrent, white changing like the cap.

Stem firm, solid.

Spores pure white, subglobose 7-8μ, nearly smooth.

This species has the lamellæ of *R. adusta,* but its flesh changes to red then black as does that of *R. nigricans.* Bresadola considers it merely a form of *R. adusta,* which may well be true. It is rather common in the western part of the State.

Notes by Coker follow:

1155. Swamp of New Hope Creek, near Durham bridge, July 18, 1914. Spores white, spherical, minutely tuberculate and brokenly reticulated, 7-9μ.

11. **Russula nigricans** (Bull.) Fr.

PLATES 76 AND 111.

Cap 7-17 cm. broad, dingy-white when young, becoming gray with age and smoky-brown or black in drying, slightly viscid, firm and fleshy, convex then depressed at the center. Flesh thick and solid, white, becoming red then black when wounded, taste mild.

Gills thick, white, distant, alternating long and short, in robust specimens almost 2 cm. broad at the center, rounded behind, becoming black with age and in drying.

Stem firm, solid, white, 3-4 cm. long, 2-3 cm. thick, changing like the flesh of the cap.

Spores pure white, nearly smooth, broadly ellipsoid, 7-8μ long.

This is not rare in our Asheville woods. The broad distant gills and the quick change of the flesh to red and then black when wounded easily distinguish it. It is recommended as an edible species, but its appearance is unattractive.

Notes by Coker follow:

This species is common in Chapel Hill, and appears as described above except that the flesh is often smoky-gray when first exposed, then turning red and finally black when bruised. The odor of young plants is hardly noticeable, but old ones have a rather distinct odor of old ham. Spores pure white, spherical to oval, slightly roughened, 7.4 x 7.4-9.2μ.

1151. Open grove west of campus, July 16, 1914.
1152. On bank by road, just east of athletic field, July 16, 1914.
1206. By Battle's branch, just east of Dr. Battle's house, July 24, 1914.
1378. In woods with cedars, northwest of Glenn Burnie barn, October 18, 1914. Spores 5.9-6.8 x 6.8-8.5μ.
1819. Pine woods at top of Lone Pine Hill, September 16, 1915.
1955. Under *Pinus inops* on hillside just north of King's millpond, October 31, 1915.
2074. Shaded lawn of the old Mangum Place, June 12, 1916. Taste moderately peppery; cap viscid; flesh turning red, then blackish.

Balsam, North Carolina (Jackson County), mountains (our No. 1640), July 23, 1915. Miss Totten.

12. **Russula ochroleuca** Fr.

Schweinitz reports this species from North Carolina, but no others have recognized it here, and the only American station given by Miss Burlingham is in Alabama. Her description is as follows (N. Am. Flora **9** :218. 1915):

"Pileus fleshy, becoming plane or depressed, 5-7 cm. broad; surface luteous, fading, with a thin, closely adnate pellicle, polished; margin even, remotely striate when old; context acrid; lamellae white, then pallid, nearly equal, rounded behind, free, broad; stripe white to cinereous, firm, spongy within, reticulate-rugose, 2-3 cm. long; spores white, ovate, papillate, 7μ in diameter. In moist places in woods."

Middle district (Schw.), woody hillsides. Curtis.

13. **Russula emetica** Fr.

PLATE 97.

Cap 5-10 cm. broad, bright rosy red to blood red, varying to white, viscid, margin at length tubercular striate. Flesh white, red under the separable cuticle; taste sharply acrid.

Gills white, nearly free, rather distant.

Stem stuffed then becoming hollow and fragile, white or reddish.

Spores pure white.

A handsome species with intensely acrid taste. It is close to the following species from which it will not be found easy to distinguish it. As I find it, it is rather larger and the gills are different, as described. Asheville.

Notes by Coker follow:

Colored illustrations: Gibson, Our Edible Toadstools and Mushrooms, Plate 13. Taylor, Food Products, II, Plate 2.

1671. In wet soil at edge of Meeting of the Waters branch, July 28, 1915. Flesh white all through, not red under the pellicle, otherwise exactly like *R. emetica*. Spores white, spherical, with very short echinulations, 6-8μ.

Blowing Rock. Atkinson.
Common in woods. Curtis.

14. **Russula fragilis** Fr.

R. subfragilis Burl.

Cap 2.5-5 cm. broad, bright red to pale red, flesh color or even white, thin, soon becoming plane or depressed, viscid when moist, margin thin, tuberculate striate; flesh very thin, white; taste sharply acrid.

Gills adnexed, thin, crowded, equal, white.

Stem soon hollow and fragile, white.

Spores white, subglobose, 7-8μ long, echinulate.

In woods and open places, common.

This species is found throughout the growing season and is easily separated from all its relatives except *R. emetica*.

Middle district (Schw.), in woods. Curtis.

15. **Russula cinerascens** n. sp.

PLATES 78 AND 111.

Cap 8-12 cm. broad, convex, then depressed at the center, viscid when moist, dull flesh-red, to cinnamon buff, fading to sordid gray with olive and vinaceous tints at maturity, at length striate on the margin, cuticle separable on the outer third. Flesh white, becoming cinerous with age; taste mild.

Gills rather close, white, then pale cream, forking 10 mm. broad at the center, attenuate toward the stem, a little rounded behind.

Stem white, spongy within, nearly equal, quickly becoming red, then black when wounded; in mature plants entirely cinerous within.

Spores pale maize yellow, nearly globose, nearly smooth 7-9μ.

This is one of our most interesting species. The color is quite variable. In the numerous collections found this year the plants in woods are quite uniformly more or less red or dull vinaceous. In plants found in open places the red is almost entirely lacking and the plants are then almost Ridgway's cinnamon buff. As they reach maturity, the flesh of the entire plant becomes cinereous and the color of the cap becomes sordid gray with tints of olive and vinaceous.

The species seems to suggest *R. depallens* Fr., but a careful attempt to connect the two has not been successful. Several European specialists to whom our plant has been submitted are positive in their belief that it is unknown in Europe, and that it is not *R. depallens*. Only three red Russulas seem to have the curious change of flesh noted in this plant. The difference in the spore characters of this species and *R. decolorans,* to which it seems related, is very marked. In specimens of *R. decolorans* from North Carolina and Sweden the spores are elliptic, 9-11μ, and coarsely tuberculate. Under a good oil immersion objective their contrast to the smaller, nearly globose, and nearly smooth spores of this species is very striking.

16. **Russula albida** Pk.

PLATES 79, 80, AND 111.

Cap 2-5.5 cm. broad, creamy white with the center often a deeper cream or yellowish, viscid when moist, cuticle separable halfway to the center, margin becoming slightly striate with age; taste mild then bitterish.

Gills white or creamy white, nearly equal, adnate and slightly decurrent.

Stem pure white, usually tapering upward, stuffed then hollow, 2-7 cm. long, 8-12 mm. thick.

Spores creamy white, ellipsoid to subglobose 7-9μ long spinulose.

Forms of this species found growing along woodland roads have always an elongated, slender stem. Forms in lawns are always much shorter with the stem 2-4 cm. long. The species is common in woods and in lawns under trees at Asheville.

Notes by Coker follow:

We have found this in Chapel Hill, but the description below is of a fresh plant that was collected in the mountains and sent to us, arriving in fine condition (No. 1641).

Cap 10.5 cm. wide, depressed in center, smooth, the margin faintly striate, surface smooth, slightly viscid, light cream on margin, yellowish in center. Flesh pure white, firm and very brittle, about 6 mm. thick near stem, mild at first, faintly bitterish after some time.

Gills all of the same length, attached but slightly rounded at stem, not at all decurrent, 6 mm. deep, nearly pure white, brownish when bruised.

Stem 5 cm. long, 2 cm. thick, equal, pure white or with brownish stains at base, quite smooth, very firm.

Spores (of No. 1641) light cinnamon buff, nearly maize yellow of Ridgway, subspherical to ovate, distinctly echinulate, 5.5-6.2 x 6.2-7.7μ.

This plant agrees well with *R. albida* except in size, which is twice as large as the maximum allowed by Beardslee (above) or Miss Burlingham.

2573. In mixed pine and oak woods, Battle's Park, July 2, 1917.

2606. Mixed upland woods just above Theater, Battle's Park, July 7, 1917. Taste mildly bitterish when brought in (just mature), the next day still fresh under a damp chamber) distinctly though slowly acrid.

Balsam (Jackson County), in mountains, July 23, 1915 (Miss Totten); our No. 1641. Photo.

Blowing Rock. Atkinson.

Hartsville, No. 27, near base of a pine, flat woods back of Hartsville plantation, June 29, 1917. Taste mild. Photo.

17. **Russula flava** Romell.

PLATE 81.

Cap 4-8 cm. broad, convex, becoming nearly plane, yellow, slightly darker at the center, margin even at first, becoming slightly striate with age, viscid when moist.

Gills white, then cream color, becoming darker in drying, thick, rather narrow, adnexed.

Stem white, equal, becoming cinereous with age.

Spores cream color 7-8μ long, broadly ellipsoid, spinulose.

One collection made July 19, 1916, at Asheville, is referred here, though with some doubt. It seems the same as the plant collected in Sweden and called *R. constans* by Romell, and later changed to *R. flava*. It is certainly rare in our State.

Notes by Coker follow:

Cap 4 cm. broad, convex, smooth (minutely granular under a lens), viscid when damp, creamy white or light yellowish all over, the margin not striate. Flesh pure white at first, but when cut turning light cinereous after some time, firm, not very brittle, about 5 mm. thick at stem, mild and odorless.

Gills rather close, none short, some branched near the stem, sinuate and narrowly adnexed, broadest and about 4 mm. wide near the outer end, veined at cap, the margins minutely denticulate, pure white at first, then faintly creamy in age, when bruised turning ochraceous or smoky after a long time.

Stem 3.1 cm. long, 1 cm. thick, nearly equal, puberulent, white or faintly creamy, and in age becoming tinted with cinereous, particularly below, solid.

Spores nearly pure white (faintly creamy), ovate-elliptic with a large eccentric mucro, minutely spinulose-warted, 4.8-5.5 x 5.5-7.4μ.

This firm and attractive species is easily separable from *R. albida* by the lighter spores with smaller spines and by the absence of a bitterish taste; and from *R. albidula* by the yellowish tint, light spores, and mild taste. Our plant is only lightly tinted with yellow, giving the effect of cream over white.

2532. By path in mixed pine and oak woods back of athletic field, June 20, 1917. Photo.

18. **Russula flavida** Frost.

PLATES 82 AND 111.

Cap 5-10 cm. broad, firm, convex, then expanded, and plane or somewhat depressed at center, chrome yellow, sometimes darker at center, dry and minutely pruinose, margin even. Flesh thin, white, taste mild.

Gills at first pure white, cream color or slightly dingy with age, not crowded, adnate.

Stem firm, becoming spongy within, colored like the cap or a little paler.

Spores cream color, subglobose, 6-8μ, delicately reticulate.

Common throughout the summer at Asheville. This is one of the easiest of our species to distinguish. The clear chrome yellow of the cap and stem, and the pure white gills of the young plant mark it at once.

Notes by Coker follow:

Cap up to 7 cm. broad, strong yellow in center, lighter yellow on the margin, dull and smooth, margin not striate except a little when old, convex, slightly depressed in center, dry; taste mild.

Gills not crowded, broad and rounded at outer end, pointed at stem, about 5-6 mm. wide, whitish then pallid yellow, scarcely any short ones, veined at the cap.

Stem 5-6 cm. long, about 1.5-2 cm. thick, yellow all over or whitish at very top, and at times orange at base, smooth, stuffed but often quickly hollowed by grubs.

Spores creamy yellow, roughened, tuberculate, nearly spherical, 6.3 x 7μ, not counting the distinct umbo.

122. Ravine back of Tenny's, October 2, 1909.
465. Woods near Battle's branch, back of Dr. Wilson's, September 30, 1912.
494. Battle's Park, near branch, October 4, 1912. Photo. Spores creamy yellow, subspherical, tuberculated and imperfectly reticulated, 7 x 8.3μ.
786. Path to Meeting of the Waters, near the brook, September 13, 1913. Spores creamy yellow, spherical, minutely tuberculate, 5.5-6.5μ.
810. In woods east of Graded School house, September 22, 1913.
1390. Battle's Park, near east gate of campus, October 20, 1914.
1582. Swamp of New Hope Creek, below Durham bridge, June 26, 1915.
2092. Dr. Lawson's lawn, June 14, 1916.
2566. Mixed woods, Battle's Park, July 2, 1917.

Middle district (Schw.), in woods (as *R. lutea?*). Curtis.

19. **Russula decolorans** Fr.

PLATES 83 AND 111.

Cap 5-10 cm. broad, orange yellow, becoming pale yellow and then pallid, convex then expanded and depressed, viscid when moist, striate and tubercular on the margin when mature. Flesh white, taste mild.

Gills thin, close, white then yellowish, adnexed, often in pairs.

Stem 5-10 cm. long, cylindrical, solid but spongy within, white, becoming cinereous especially within with age.

Spores pale yellow, broadly ellipsoid, 8-10μ, spinulose.

Rare in the western part of the state, probably more common in the eastern portions. The cinereous discoloration of the flesh of the stem and cap with its color will distinguish it.

On the upper slopes of Mount Mitchell. Fine specimens in some abundance. Not found as yet at lower levels at Asheville.

Notes by Coker follow:

This species is much like *R. flavida* in color, but is usually more orange, and may otherwise be distinguished by the longer, white stem and very different spores.

573. Near Howell's branch, October 17, 1912. Stem almost pure white, longer than in *R. flavida*. Spores creamy yellow, distinctly sharp-spinulose (not reticulated), subspherical, 7.5-8 x 8.5μ.

Middle district (Schw.), in pine woods (as *R. depallens?*). Curtis.

20. **Russula pusilla** Pk.

PLATES 84 AND 111.

Cap 1-3.5 cm. broad, convex, soon expanded and depressed at the center, bright red, or dull carmine, sometimes fading to almost buff, glabrous, viscid when moist, margin becoming slightly striate, cuticle separable nearly to the center. Flesh red under the cuticle, otherwise white; taste mild.

Gills white, then pale yellow, not crowded, equal, slightly rounded behind.

Stem pure white, rather slender, soon hollow within.

Spores maize yellow, 7-9μ long, broadly ellipsoid, marked with spines and ridges.

Growing in lawns under oaks and along roads in woods.

Specimens found at Asheville seem to agree with a specimen from New York. They are larger than the limits of size in the original description, but not exceeding the size as Miss Burlingham finds it. It is fairly common at Asheville and seems to belong here.

Notes by Coker follow:

Small plants growing scattered in grass in lawns under oaks. Cap 3-4.5 cm. (rarely 5 cm.) broad, irregular, depressed in center, decidedly or slightly striate on the margin when mature, glabrous, viscid when damp, cuticle removable to near the center; color a dull brownish or vinaceous purple-red, the center darker, some pale, others fairly dark. Flesh thin, only about 2 mm. thick in center, white, soft, fragile but not very brittle, mild and odorless.

Gills not crowded, up to 7 mm. wide near the rounded marginal end, pointed and some of them sinuate at the stem, a few branched near the stem, no short ones, strongly connected by veins; color light, then at full maturity buff yellow (Ridgway) in edge view, and maize yellow on side view.

Stem 2-3 cm. long, 5-8 mm. thick in center, tapering downwards, glabrous, pure white and not turning yellow when wounded, minutely rugulose, softly stuffed, then hollow.

Spores buff-yellow in thick print, subspherical, distinctly blunt-echinulate (oil emersion), 6.6-9.2μ.

These plants agree well with *R. pusilla* Pk., except that they do not grow under pines.

1090. In grass, old Holmes Place, July 6, 1914. Photo.
2112. Under oaks in Mr. J. M. Williams' lawn, June 15, 1916. Photo.
2114. Grass under oaks by Infirmary, June 16, 1916.
2134. In grass in northwest corner of Arboretum, oaks near, June 17, 1916.
2185. Poor soil in Dr. Venable's lawn, June 21, 1916.
2537. Under oak in Arboretum, June 21, 1917.

21. **Russula meliolens** Quél.

PLATES 85 AND 111.

Cap 5-10 cm. broad, dull red or brownish red, to pale faded red, convex, firm, viscid when moist, becoming striate on the margin, smooth; taste mild; odor in drying strong of new meal.

Gills white, then cream color, rather thick, distant, broad, rounded and nearly free behind.

Stem firm, becoming hollow, nearly equal, colored like the cap at the base.

Spores cream color, subglobose, 10-12μ long, appearing smooth under a 1/5-inch objective, delicately warted with faint reticulating lines under higher magnification.

One of our most abundant species at Asheville, especially in open places under trees. It is easily recognized if the spores are carefully examined. The peculiar oder is very characteristic.

Notes by Coker follow:

Cap 5-6.5 cm. wide, convex then expanded, viscid, light purplish brown in center, buffy-vinaceous with yellowish stains on the margin; margin striate. Flesh white, about 5-7 mm. thick, yellow around grub channels; taste mild.

Gills equal, not crowded, veined, 8-9 mm. wide, white then faintly tinted with creamy-flesh, turning yellow-ochraceous or brownish when bruised.

Stem 4-7 cm. long, up to 8 mm. thick in center, nearly equal, white with stains of yellow-ochre, but not turning yellow at once when scraped as in *R. puellaris.*

Spores faintly creamy white, spherical, very minutely roughened (more nearly smooth than any of the other species), 7.4-9.2μ.

Much like *R. puellaria,* but stem does not stain yellow at once, and the spores are different. Old bruises show yellowish or brownish on all parts.

2128. Mixed woods (pine, oak, etc.) at top of Lone Pine Hill, June 17, 1916. Photo.

2272. Mixed woods, Lone Pine Hill, June 27, 1916. Cap up to 10 cm. broad, viscid; stem up to 6.5 cm. long and 1.7 cm. thick at cap; gills and stem turning quickly brownish when bruised; spores subspherical, very minutely roughened, 7.4-11μ.

22. **Russula mariae** Pk.

PLATES 86 AND 111.

Cap 2.5-7.5 cm. broad, crimson to purple or purplish-gray, dry, pruinose, even on the margin when young, striate when old, firm; flesh white, colored under the cuticle; taste mild.

Gills adnate, rather close, white, becoming cream color, often red on the margin, which is thickly set with projecting cystidia.

Stem colored like the cap, but usually paler, stuffed.

Spores light yellow, globose, 7-8μ broad, delicately reticulate.

In woods, not rare, Asheville.

This is certainly Peck's plant. I have seen no specimens of *R. punctata* Quel., which seems closely related. Maire lays particular stress on the structure of the margin of the gills in characterizing Quelet's species. In my specimens the margin is floccose when examined with a lenz and thickly set with pointed cells, which often project 50μ beyond the other cells. This corresponds closely with his notes. The species may very possibly not be distinct.

Notes by Coker follow:

Cap up to 10 cm. broad, depressed in center or cup-shaped by the elevation of the margin which is not striate or faintly so at maturity, and with a strong tendency to crack deeply almost to the stem into several segments in age; surface scarcely at all viscid, except when bruised, and then decidedly so, granular pruinose or somewhat crustose-scurfy as in *R. crustosa;* cuticle separable almost to center. We have two distinct color forms that do not intermix in any one place, though somewhat intermediate colors are occasionally found; in one the color is deep vinaceous purple, sometimes with tints and areas of old-gold or olive-gold, faded in places, often becoming blackish purple in age; in the other the color is dull red, exactly coral red, or dragon's blood red of Ridgway (in the plant No. 2351 the color was light olive and pallid tan with only a slight tint of purple in a few spots). Flesh about 5 mm. thick near center, firm and not very brittle, white then brownish after considerable exposure, mild.

Gills not crowded, almost all the same length, a few or none or many forked, pointed at the stem and just reaching it, rounded at the broad outer end, where they are about 6-8 mm. wide, veined at cap, not very brittle, nearly white when young, becoming cream color, brownish when bruised, the margin varying from distinctly rosy to no sign of rose, and dotted with minute drops when fresh like the stem.

Stem about 3.5-5 cm. long and 8-20 mm. thick at cap, largest below

usually, rosy or vinaceous red from granular dots, covered also when at all fresh with minute clear droplets of viscid dew; rarely nearly white in the red form, softly stuffed or cavernous.

Spores (of No. 2187) about cream color, subspherical, distinctly set with blunt spines and ridges, 4.4-7.4μ. Gill margin with numerous, long spine-like cystidia, projecting about 30-40μ.

2131. Under oaks in old Mangum lawn, June 17, 1916. Photo. with 2132. Spores spherical to subspherical, covered with blunt spines of unequal length, nearly maize yellow, 5.5-7.4μ.

2132. Under oaks in Battle's Grove, near east gate of campus, June 17, 1916. Purple form. Photo.

2186. Dr. Venable's lawn, June 21, 1916. Red form. Spores with ridges and spines, some much more ridged than others, 6-7.5μ.

2187. Under oaks in Professor Howells' lawn, June 24, 1916. Purple form.

2336. Dr. Wagstaff's lawn, July 1, 1916. These are the red form. They have been appearing here and along the sidewalk near for a month, and are very unlike the deep vinaceous plants of No. 2132, No. 2247, etc. All other characters are the same, except that the stem while covered with the same granules (color of cap) is less sticky than the deep colored forms, though slightly so. Gill margins usually red dotted, etc. Spores subspherical, with ridges and tubercles, 6.5-7.7μ. Cystidia numerous and like those of No. 2186.

2351. In upper road to Scott's Hole, gravelly soil, top of hill beyond Rocky Ridge Farm, July 3, 1916.

2580. Mixed woods by Battle's Branch, July 2, 1917. Cap blackish vinaceous in center, fading to olive gray on margin.

23. **Russula cyanoxantha** Fr.

PLATE 87.

Cap 7.5-12.5 cm. broad, convex, then plane or depressed, viscid when moist, purple-gray shading into green, margin at first even, at length slightly striate; flesh firm, white; taste mild.

Gills white, becoming pale cream color, close, somewhat forked, a few shorter.

Stem firm, white, stuffed, equal.

Spores creamy white, subglobose, 8-9μ long, marked with raised lines which form slight reticulations.

In woods, rare in Asheville.

This species has been detected only a few times. In appearance it is much like *R. variata,* but is clearly distinct from it. The spores

are never chalk-white as in the latter species, but always creamy white, and the taste in my specimens is mild. It may be said that the status of this species is not altogether satisfactory. Romell makes the creamy white color of the spores the decisive character in separating this species. Maire refers here a species with pure white spores, and specimens from him are different from ours. Our plants are, however, the same as those so referred in N. Am. Flora, and by Peck.

Notes by Coker follow:

Cap up to 10 cm. broad, convex, then depressed in center, striate on margin. Surface smooth, viscid when wet, dull and with very peculiar shades of color, purplish red in center, fading to olive or bluish-olive or a mixture of these with purple, or light purplish all over with pallid spots. Young plants are sometimes a deep dull-olive all over with a tint of purple, the margin usually with more purple. Flesh white or grayish, very thin near margin; taste mild or slightly peppery.

Gills white, often forked, moderately close, adnexed, connected at cap by veins, turning brown where bruised.

Stem short, about 3-4 cm. long, usually about 1 cm. thick, dull, pure white, stuffed and very fragile.

Spores oval, minutely tuberculate, cream, 4.8-6.7 x 7-8.2μ.

704. In woods near Battle's Branch, June 20, 1913.
864. Woods southeast of schoolhouse, October 2, 1913.
1552. Woods near branch above Meeting of the Waters, June 18, 1915. Spores nearly white, spherical to elliptic, 5.4-7.2 x 7.2-9μ. Plants dull olive with purple tint on margin.
1569. Battle's Park, June 21, 1915. Spores mostly spherical, some slightly elongated, minutely tuberculate, 5.8-7.5 x 7.2-9μ.
2516. Cultivated border in the Arboretum, June 14, 1917. Cap dull vinaceous purple with olive tint on margin, taste mild or faintly peppery. Spores cream color, subspherical to short oval, warted (not reticulated), 5.5-6.5 x 5.9-7.4μ.

24. **Russula virescens** Fr.

Cap 5-10 cm. broad, round, convex then expanded and depressed, dull green or greenish-gray, cuticle breaking into flocculent warts, even on the margin except in old plants, dry; taste mild.

Gills white, then cream color, moderately close, narrowed toward the stem, a few forked and unequal.

Stem white, becoming spongy within, equal.

Spores white, with a faint cream color, globose, echinulate, 6-7.5μ.

In woods and open groves, not rare, Asheville.

This species is deservedly considered an excellent edible species. It is also not difficult to determine, being one of the first of the Russulas to be recognized with certainty. I do not find the spores chalky white, but rather creamy white. In age the green color may nearly disappear.

Colored illustrations, Gibson: Our Edible Toadstools and Mushrooms, Plate 11. Taylor; Report of Chief of Div. of Microscopy, U. S. Dept. of Agri., Plate 1, 1893.

Blowing Rock. Atkinson.
Middle district (Schw.), in woods. Curtis.

25. **Russula crustosa** Pk.

PLATES 88 AND 111.

Cap firm, 5-10 cm. broad, dingy gray, greenish gray, sometimes with dingy purple or yellowish shades, cuticle breaking as the cap expands and forming closely appressed scales, convex but depressed at the center, striate on the margin, taste mild or slightly acrid.

Gills white, close, narrow, somewhat forking and unequal.

Stem white, stuffed then hollow.

Spores pale cream, echinulate, 6-7 x 8-9μ.

Very common in woods at Asheville. The cap seems to be covered with a "crustose" cuticle which breaks up as the cap expands into scales. It is unlike all other species, being closest to *R. virescens,* which will be easily distinguished from it.

Notes by Coker follow:

Cap up to 11.5 cm. broad, usually 7-9 cm., viscid when moist, the surface with slightly elevated lines and riculations and inherent scaly patches, very much as in *R. virescens;* depressed in center, the slightly striate margin curved downward in youth, upward in age, and more or less wavy; color very variable, usually light lilac with deep olive

and tan shades in center, or at times a brownish olive buff with scarcely a tint of lilac. In collection No. 1142 the color changed little from youth to maturity. Flesh pure white, not becoming red when cut, about 8 mm. thick halfway to margin, almost tasteless, not tardily acrid in our plants.

Gills white, becoming pallid tan and in old age blackish-brown on margins, squarely joining the stem or slightly notched, broadest near margin, where they are 5-6 mm. deep, not close, many short and a few forked ones, thick at cap, distinctly veined, the edges very smooth and even.

Stem short and thick, about 4.5-5.5 cm. long and 1.5-2 cm. thick; pure white or with a faint tint of lilac, creamy or brownish at base. Surface smooth except for slightly elevated ridges and lines; flesh white and solid.

Spores (of No. 1142) spherical to oval, minutely echinulate 6.4-7.2 x 6.4-9.2μ.

1142. In open oak grove east of campus, July 16, 1914. Photo.
1568. By path below Lover's Leap, Battle's Park, June 21, 1915. Photo. Spores cream color, spherical or subspherical, minutely echinulate, 5.4-7.2 x 5.4-9μ.
1658. Near Howell's Branch, July 27, 1915.
2061. Shaded lawn in old Mangum Place, June 11, 1916. Photo.
2078. Grove at "The Rocks," June 12, 1916.

Blowing Rock. Atkinson.

26. **Russula albidula** Pk.

PLATES 89 AND 111.

Cap 5-12.5 cm. broad, firm, at first round convex, soon depressed at the center, pure white, viscid when moist, margin even or faintly striate with age; flesh white; taste intensely acrid.

Gills white, becoming cream color, 7-8 mm. broad at the center, narrowed toward the ends, somewhat forked and unequal.

Stem pure white, firm, solid, equal.

Spores about maize yellow, broadly ellipsoid, 6-8μ long, marked with spines and raised lines, which often form broken reticulations.

This species is abundant at Asheville in pine woods, and is particularly abundant in the late fall. It is one of our most acrid species and will easily be recognized by its white color and sharp taste.

Notes by Coker follow:

Cap 7 cm. broad, expanded, depressed in center, the very margin faintly striate or even, surface smooth, pure white with buff or brownish stains, slightly viscid when moist. Flesh soft, rather thick, white, intensely or mildly acrid.

Gills crowded, none branched, slightly decurrent, 5-6 mm. wide, rounded at margin, the edges finely serrate, veined at the cap, color white then creamy.

Stem 2.5 cm. long, 1.5 cm. broad at tip, tapering downward, pure white, solid but the center soft.

Spores (of No. 1780), light ochraceous, subspherical to short elliptic, closely short-tuberculate, 5.5-6.5 x 6.3-8.5μ.

In Chapel Hill this species varies much in its acridity and is found under cedars as well as pines: common. I doubt if this is different from *C. albida*.

This seems to be the plant described by Curtis in the Curtis-Berkeley Mss. as follows:

> "2812. (*Ag. albus* Fr.). Cap convex, very smooth and soft, whitish, alutaceous, 2-2½ in. broad. Flesh white, compact, brittle, thick. Lamellæ numerous, not crowded, in 4-5 ranks, thin, sometimes forked at base, adnate with a decurrent tooth, white, arcuate towards the margin of the cap, ventricose toward the stipe, margin irregularly erose denticulate, extending to the edge of the cap, narrow. Stipe white, subequal, 2-2½ in. long, 3-4 lines thick (becoming hollow?), farinose above, myceloid pilose below. Spores white. Taste and odor fungose. Among leaves in pine woods, attached to wood and chips. October."

1533. Pine woods at top of Lone Pine Hill, October, 1914. Spores spherical to short elliptic, 5.1-6.8 x 5.9-8.5μ. Under an emersion lens the spores are seen to be minutely tuberculated. I cannot see that they are also reticulated, as Beardslee thinks.

1780. In same grove as No. 1533, September 14, 1915.

1909. In pine woods by road south of athletic field, October 18, 1915.

1956. Under *Pinus inops*, near King's Mill, October 31, 1915.

2567. Under cedars, Mrs. Kluttz's yard, July 2, 1917.

27. **Russula sanguinea** Fr.

PLATES 90 AND 111.

Cap 5-10 cm. broad, convex, then expanded and depressed at the center, deep red to pale red, viscid when moist, at length striate on the margin; taste very acrid.

Gills white, then pale yellow, forked and unequal, adnate or decurrent.

Stem usually red, but paler than the cap, equal, glabrous, becoming spongy within.

Spores pale yellow, broadly oval or almost globose, 8-9μ long, strongly spinulose.

Abundant at Asheville, especially in our pine woods.

Our specimens are exactly like those which are found in Sweden. The species seems to have been misunderstood in the United States. Its intensely acrid taste and pale-yellow spores distinguish it from our other species. It is closely related to *R. rosacea* Fr., which differs in never having the gills decurrent. Some of our specimens could well be referred to the latter species.

Notes by Coker follow:

Gregarious and sometimes cespitose in groves and woods. Cap 3-7 cm. broad, plane or slightly convex, dull but not pruinose, only slightly viscid, cuticle only removable for a little way; margin slightly striate; color deep dull red, darkest in center. Flesh up to 4 mm. thick at cap, soft, white, quite acrid.

Gills rather distant, a few short and some forked near stem, up to 5 mm. wide near the rounded outer end, veined, adnexed and usually slightly sinuate or rounded at stem, none decurrent in our plants.

Stem 2-3 cm. long, 5-13 mm. thick, smooth, dull, usually tinted like the cap, but lighter, stuffed and usually hollowed.

Spores cream color, about maize yellow, moderately echinulate, elliptic, 4.8-7.4 x 5.5-8μ.

2246. Under oaks by Gimghoul Lodge, June 24, 1916.
2308. Mixed woods at top of Lone Pine Hill, June 29, 1916.

28. **Russula lepida** Fr.

PLATES 91, 92, AND 111.

Cap 5-15 cm. broad, very firm, convex, then plane and depressed at the center, dry, unpolished, usually becoming rimose squamous, color varying from bright red to pale rosy red and pallid or even white. Flesh white, firm, somewhat acrid.

Gills thin, rather narrow, white, narrowed toward the stem, somewhat forked and unequal, frequently red on the margin.

Stem firm, solid, colored like the cap, but lighter, sometimes white.

Spores creamy white, nearly globose, 7-8μ, not strongly spinulose, but marked with warts and a few raised lines.

This is one of our commonest and most variable Russulas. The very firm substance helps to distinguish it. Its taste is also characteristic. It is not acrid in the ordinary sense, but has rather a peculiar aromatic sharpness which Romell compares to the taste of pine needles. Very many specimens have been examined this summer for the color of the spore mass. I find it in every case pale cream, which in thin deposits might well be called white. It has, however, a distinct cream color, though it is decidedly lighter than maize yellow.

Reported as occurring in pine woods in the low districts by Curtis. Probably general through the state.

Notes by Coker follow:

Cap 4.5-12 cm. wide, expanded and irregular, the margin rounded, plane or slightly elevated in places, the center plane or slightly depressed; surface distinctly pruinose and often separating into distinct granules or scurfy areas, and characteristically much cracked and broken at full maturity; color rosy pink or rosy red (Corinthian pink to Pompean red—Ridgway) or grayish-blue-pink with yellowish or golden areas in center and sometimes very pale places; some young plants are deep dull red all over or red-gold in center and gold on margin, and old plants become pinkish-pallid with a buffy center and very spotted. Flesh white, dry, quite firm and solid, not fragile, about 5-6 mm. thick near center, distinctly but mildly acrid or bitterish-acrid.

Gills moderately close, a few or a good many or none forked and some short, nearly white then cream color, sometimes *turning distinctly a clear lemon yellow when bruised*, and after a while reddish ochraceous, sometimes turning slowly to sordid yellowish without the quick change to bright yellow, up to 1 cm. wide, the outer end rounded, narrow at stem, distinctly attached, veined.

Stem pure white all over usually or lightly tinted with rose, turning

yellow or sordid and then brown when rubbed, 3-6 cm. long and 1.3-3 cm. thick at top, usually largest below, solid, stuffed, surface dull, rugulose.

Spores creamy-white, subspherical, very minutely roughened, 5.9-8.5μ.

Colored illustrations: Gibson, Our Edible Toadstools and Mushrooms, Plate 12. Palmer, Mushrooms of America, Plate 6.

2173. Under oaks in Battle's Grove, June 20, 1916.
2213. Under oaks, lawn of "The Rocks," June 24, 1916.
2249. Under oaks, Professor Howell's yard, June 24, 1916. Spores cream color, subspherical, moderately tuberculate, 7.4-10.3μ.
2256. Battle's Grove (oaks), June 26, 1916.
2258. Battle's Grove (oaks), June 26, 1916. Photo.

29. **Russula foetans** Fr.

PLATES 93 AND 111.

Cap 5-12.5 cm. broad, dingy yellow to brownish yellow, becoming expanded and depressed at the center, viscid, the margin deeply tubercular-striate; taste acrid.

Gills whitish, crowded, adnexed, many shorter and forked, often exuding watery drops, especially in young plants. Odor strong and unpleasant, especially in hot weather.

Stem soon hollow, white, cylindrical, becoming dingy when handled.

Spores creamy white, subglobose, 7-9μ long, marked with strong reticulating lines.

Common at Asheville, and easily recognized.

Notes by Coker follow:

A large plant that is common in woods, lawns and borders, and is even found in manured soil, a habitat not affected by other russulas. Taste disagreeable at first, then peppery, or hardly so; odor distinct even when young, and rather disagreeable; somewhat like rubber, at maturity.

Gills sordid cream when young, and scarcely darker at maturity, except that, when bruised, they turn a sordid brown.

Under a lens the surface of both stem and cap is minutely roughened. The strong and rather disagreeable taste and odor makes this

plant useless as a food, and it has been considered poisonous, but Captain McIlvain says that "On two occasions I ate enough to convince me that it was not poisonous."

Spores (of No. 1108) spherical to slightly oval, coarsely reticulated, 6.5-7.4μ in diameter.

Colored illustration: Mycologia **4**:292, Pl. 74. 1912.

123. Battle's Park, near house, September 14, 1910.
574. Under pines on side of hill near Howell's Branch, October 17, 1912.
702. Woods along Battle's Branch, June 20, 1913.
865. Woods south and east of Graded School, October 2, 1913. Photo. Spores light cream, spherical, spinulose, one large oil drop, 6.5-9.2μ in diameter.
1091. Campus, north side, July 6, 1914.
1108. By path along west branch of Meeting of the Waters branches, July 9, 1914.
1604. In low damp place by Battle's Branch, July 12, 1915. Spores spherical, tuberculate, 8-10μ in diameter.
2116. In grass on campus, June 16, 1916.

Blowing Rock. Atkinson.
Middle district (Schw.), woods. Curtis.

30. **Russula pectinata** Fr.

PLATES 94 AND 111.

Cap 4-8 cm. broad, deep gray-brown (dark bistre, Ridgway), when fresh and young, becoming paler with age, and brownish gray, usually darker at the center, viscid when wet, flesh thin, margin deeply striate halfway to the center; taste slowly acrid.

Gills white, nearly equal, a few forking near the stem, rather close.

Stem white, equal, glabrous, stuffed then hollow within.

Spores cream color, ellipsoid, spinulose 7-8 x 5-6μ.

I find this in lawns under oaks. The cap is almost black at first in some specimens. The odor is much less unpleasant than that of *R. fœtans.* The spores are also distinctly different from those of *R. fœtans* when they are highly magnified. My specimens closely resemble Boudier's figure of *R. sororia* Fr.

31. **Russula pulverulenta** Pk.

PLATES 95 AND 111.

Cap rather thin 4-8 cm. broad, pale cream, sprinkled with ochraceous granules, which are close together at the center and scattered toward the margin, striate and tuberculate on the outer third; taste mild; odor in fresh plant not noticeable.

Gills white, nearly equal, a few forking near the stem, rather thin, not crowded, adnate.

Stem stuffed, contracted above, thickly set with yellow granules, which are less dense at the apex.

Spores elliptic 7-8 x 6-7μ, marked with spines and ridges.

Only one specimen of this interesting species was found. It is a very distinct species and agrees well with the descriptions, except that I do not find the spores globose.

32. **Russula luteobasis** Pk.

PLATE 96.

This has been found in North Carolina at Chapel Hill only, and the following description is by Coker:

Cap 4.5-10 cm. broad, plane and usually depressed in center at maturity, smooth, glabrous, dull, striate at maturity only on the extreme margin, only slightly viscid; color a pretty light rose on margin, shading rather abruptly to buffy-yellow in center with the latter tint in places elsewhere. Flesh about 4-5 mm. thick at stem, pure white, firm, not very brittle, quite mild.

Gills moderately close to subdistant, some short and a very few branched near stem, depressed at stem and just reaching it, about 5-6 mm. broad near the rounded outer end, veined, nearly white, then light cream color at maturity, not changing color when wounded.

Stem 3.5-5 cm. long, 8-12 mm. thick at cap, somewhat larger below, pinched at base, smooth, white above and strongly orange yellow at very base and light creamy-buff between, stuffed, then cavernous.

Spores creamy-yellow, moderately tuberculate, elliptic, 5.5-6.6 x 6.6-8.5μ.

2252. Battle's Grove (oaks), June 25, 1916. Photo.
2563. Battle's Grove, June 25, 1917.

33. **Russula rubescens** Beardslee.*

PLATES 97 AND 111.

Cap convex, then expanded and depressed, 5-9 cm. broad, red, paler on the margin, fading with age, thin, striate on the margin.

Gills rather close, white, adnate, forked, especially at the base.

Stem white, stuffed, nearly equal, becoming red then black when wounded, at length cinereous within.

Spores pale yellow, subglobose, 7-9μ long, spinulose. Cystidia numerous.

In woods, not common. Asheville.

This seems to be a well marked species. The quick change of the stem when wounded to red then black at once separates it from all other red species except *R. cinerascens*, which is amply distinct. It has been detected in Michigan and will doubtless be found generally in our State.

34. **Russula magna** n. sp.

PLATES 98, 99, AND 111.

Cap 8-15 cm. broad, round convex, then expanded, cream color to buff, darker at the center, smooth and shining, with a texture like kid as it dries, flesh white, becoming cinereous with age, very firm and solid.

Gills 5-10 mm. wide, thick rather distant, a few forking and shorter, cream color, distant from the stem, rounded behind.

Stem 5-8 cm. long, 2-3 cm. thick, white, enlarged above, often obscurely ridged, changing to red then black when wounded, becoming entirely cinereous within with age.

Spores 7-9μ, globose, nearly smooth, with delicate reticulating lines; pale buff-yellow.

In drying the cap and stem blacken more or less. The buff color of the cap often is left in patches, and the gills tend to blacken less than the other parts. In the main, however, it blackens much like *R. nigricans*. The fresh plant has a rather pungent smell, which becomes much stronger in drying and is then quite offensive. It is a

*See Mycologia 6:91. 1914.

strong "piggy" smell. Coker speaks of it as like the smell of a sweaty horse. At all events it is very powerful and very bad. The dried specimens would probably be taken for *R. nigricans*, but it is amply distinct from that species. The yellow spores, nearly equal gills, strong odor, at once distinguish it.

Asheville, as Nos. 15065, 12002, and 16083.

Notes by Coker follow:

A large and very peculiar plant. Cap 15 cm. broad, margin strongly upturned, surface smooth, shining, deep gray-brown in center, shading to nearly black on marginal third, cracked into lines and areas, especially in center. Flesh firmly spongy, a gray color, taste mild.

Gill surface light buff (Ridgway), almost cinnamon buff in deep view, not close, broadest in marginal half and abruptly rounded at ends, distant from stem and terminating abruptly, not decurrent, connected at cap by very high and conspicuous veins, 1.3 cm. deep near margin, 1 1/4 mm. thick, rather brittle, their flesh drab color like that of the cap. In drying, the gills turn almost black.

Stem 6 cm. long, 3 cm. broad in middle, tapering rapidly downward, enlarged at top, obscurely ridged, smooth, nearly white at top, then shading through light gray to a deep blackish-brown at base; flesh exactly color and texture of that of cap, solid.

Spores cinnamon buff, spherical, slightly rough, a large oil drop, 7.4-11μ in diameter.

This is somewhat like *R. nigricans*, but differs sharply in the strong odor and colored spores. It is most nearly related to *R. xerampelina* Fr. (*R. squalida* Pk.), but the size is considerably larger and the odor is different. One of the most remarkable qualities of this plant is the peculiar penetrating and persistent odor. The smell is a good deal like that of a sweating horse, only more aromatic. The odor was strong for days after the plant was brought in; and, if touched, the odor clung to the fingers for hours.

900. Battle's Park, just north of the cemetery, October 8, 1913.

35. **Russula xerampelina** Fr.

R. atropurpurea Pk.

PLATES 100 AND 111.

Cap 3-10 cm. broad, convex, soon depressed, appearing slightly pruinose under a lens, smooth, but unpolished and opaque to the naked eye, very variable in color, dull red, purple or grayish purple, olivaceous, yellow or pale orange, or nearly white, margin even or slightly striate with age; taste mild, odor in drying very strong and fœtid.

Gills white, then yellowish, rather broad, rounded behind, somewhat unequal, becoming yellow then brown when wounded, dingy brown in drying.

Stem white, equal, spongy within, becoming yellow when wounded.

Spores deep yellow, 8-10 x 7-8μ, echinulate.

This is at the same time one of our most abundant and variable species. The great range of colors is apt to give the beginner trouble. The stem, however, in all its forms quickly becomes yellow when scraped, and its strong odor in drying is very characteristic. The dingy color of the gills in the dried plants helps in identifying it. This species is abundant in Sweden and was described by Romell as *R. graveolens.* It is now considered by Romell and Maire to be *R. xerampelina* Fr., and it seems best to follow them. It is also *R. atropurpurea* and *R. squalida* Pk.

A curious form of this species, which seems not to be common, is found in our pine woods. It varies from orange to yellow, and is so distinct in appearance that it is hard to believe that it is the same as our red and purple forms. It has, however, the same microscopic structure and the same discoloration when wounded and the same strong odor when drying (see Mycologia **6**:90. 1914).

Notes by Coker follow:

Cap surface minutely tomentose-velvety, margin slightly striate in age, color of No. 1779, a peculiar deep vinaceous-purple in center, fading to much lighter dull ashy-purple on margin; color of 2115, dull vinaceous-purple with faded yellowish areas, the margin pale. Flesh light ashy-brown or sordid white, changing to a somewhat deeper

brown when cut, soft, not very brittle, about 5 mm. thick at stem, a mere membrane at margin, taste mild, odor strong and disagreeable on drying, and remaining noticeable on the hands for a long time after touching.

Gills moderately close or rather distant, a few or none forked, veined at cap, 4-8 mm. wide, pointed at stem, rounded at margin, whitish, then turning ashy-brown, then deeper in drying, brownish when bruised.

Stem 3-4 cm. long, nearly equal or tapering either way, white, turning quickly brown when bruised, somewhat pruinose, faintly rigid longitudinally, solid, flesh like that of cap.

Spores yellow (about pale orange yellow of Ridgway), subglobose, echinulate, 6.3-9μ.

Easily distinguished by the stem changing quickly to brownish when rubbed, and by the strong odor when beginning to dry.

1779. Low, damp, shaded ground at foot of Lone Pine Hill, September 14, 1915.
2115. Grass under oaks by Infirmary, June 16, 1916. Photo.

36. **Russula puellaris** Fr.

Cap 2.5-5 cm. broad, thin, slightly fleshy, convex then expanded, viscid when moist, pale purple or dingy purple, margin thin, striate; taste mild or very slightly acrid.

Gills thin, rather crowded, white, then yellow, at length pulverulent, attenuate towards the stem.

Stem stuffed, then hollow, fragile slender, becoming yellow when wounded.

Spores pale yellow, subglobose, spinulose, 6-8μ long.

In woods, rather rare. Asheville.

Specimens found at Asheville seem the same as those found in Sweden. It has been found only sparingly.

Notes by Coker follow:

2558. In moss, cool damp woods at foot of Lone Pine Hill, June 23, 1917. Easily recognized by small size, vinaceous color, and change to yellow. It is very like *R. pusilla* except for the yellow stains.

37. **Russula aurata** Fr.

PLATES 101 AND 111.

Cap 5-10 cm. broad, firm, viscid when moist, beautiful golden yellow, darker and shaded with orange at the center, cuticle separable on the margin, flesh beneath bright lemon yellow, even on the margin, becoming striate with age; taste mild.

Gills pale whitish, becoming light yellow, rounded, free, not crowded.

Stem firm, spongy within, pure white.

Spores deep yellow, ellipsoid, marked with reticulating lines, 7-9μ long.

In lawns under oaks. Asheville.

This is one of our most beautiful species. It seems to be rare in the United States, and some doubt has been expressed as to its occurrence. My specimens have exactly the spores of specimens received from Maire. The Swedish *R. aurata* is mild in taste, as is the plant I have so referred. I have found no specimens with the margin of the gills more deeply colored; but according to Maire, that is not always true of the European plant.

Notes by Coker follow:

Cap up to 8 cm. broad, lightly convex, depressed in center, margin regular, becoming slightly striate; surface glabrous, viscid, with a separable cuticle, a fine golden or orange yellow. Flesh about 4 mm. thick near stem, yellow, mild.

Gills not crowded, almost all the same length, sinuate-adnexed, about 8-9 mm. wide, thick, whitish then light yellow, their flesh yellow.

Stem up to 8 cm. long, about 1.8 cm. thick at top, somewhat irregular, constricted at base, surface glabrous, rugose, white, or with faint yellow stains; flesh white, soft inside, not hollow.

Spores distinctly yellow, spherical, spinulose, 7.4-9.2μ.

2083. Swamp of New Hope Creek, near Durham bridge, June 13, 1916.

2225. Bank of New Hope Creek, one-fourth mile below Durham-Chapel Hill bridge, June 24, 1916.

38. **Russula basifurcata** Pk.

PLATE 102.

Cap up to 9 cm. broad, soon depressed at the center, viscid when moist, white with tints of yellow and rose, especially toward the margin, glabrous, margin at length slightly striate, cuticle separable on the outer third. Flesh thin at the margin, white; taste mild, then slightly bitter and very slightly acrid.

Gills rather close, white, then cream color, forking, especially near the stem, about 5-7 mm. broad at the center, narrower and slightly emerginate toward the stem.

Stem white, stuffed, about 4 cm. long, 1.5 cm. thick.

Spores pale yellow, a little darker than Ridgway's maize yellow, round ellipsoid to subglobose 6-7μ. The spores of this species are a shade lighter than those of *R. olivascens*. The colors of the two species are quite different. I find this rather rare.

39. **Russula grisea** Pers.

R. glauca Burl.

PLATE 103.

Cap 6-10 cm. broad, soon becoming depressed at the center, dingy-white or creamy-white, tinged with yellow at the center, sometimes reddish to buff-red, viscid when moist, cuticle separable halfway to center, even on the margin; taste mild.

Gills white, then cream color, adnate, many forking at or near the stem, almost none short.

Stem white, firm, equal, short, 2 cm. long, 1-1.5 cm. thick.

Spores pale yellow, broadly elliptic, 7-8μ long, marked with spines and a few raised lines which form broken reticulations.

This species is found in abundance at Asheville in lawns under oaks. It seems to shade into the following species. I find it occasionally in groups in which some plants have a distinct olive green tint, while others are typical and white or creamy-white.

Notes by Coker follow:

Cap up to 9 cm. broad, depressed in center, margin slightly striate, color dull straw in center, the margin pallid straw and striate for a little way at maturity; cuticle viscid, removable.

Gills hardly crowded, some forked at base, none short, veined at cap, creamy-yellow (maize-yellow) at maturity, decidedly lighter than the spores.

Stem about 5 cm. long, 18 mm. thick, rugulose, white, becoming cinereous below, spongy within, exactly light cream yellow of Ridgway.

Spores subspherical to short elliptic, short spinulose, a clear creamy yellow, 4.8-5.5 x 5.5-7.4μ, exactly like the spores of Beardslee's plant.

2564. Oak grove in front of Dr. Battle's, June 25, 1917. Photo.

40. **Russula olivascens** Fr.

PLATE 111.

Cap 4-10 cm. broad, convex, then depressed at the center, olivaceous, with the color deepest at the center, and pale toward the margin, viscid when moist, margin even; taste mild.

Gills white, becoming cream color then yellow, rounded behind, somewhat forked, a few shorter.

Stem white, firm, glabrous.

Spores broadly elliptic, pale yellow, 7-9μ long, marked with spines and raised lines which form broken reticulations.

In woods, not rare. Asheville.

The spores of this and the preceding species are a deep creamy yellow, about pale orange-yellow of Ridgway.

Notes by Coker follow:

Cap up to 9.5 cm. broad, depressed in center at maturity, margin rather faintly or clearly striate, surface glabrous, viscid and much stuck with dirt, dull olivaceous or pale brownish olivaceous and sometimes with faint purplish tints, margin even or slightly striate, cuticle removable about one-third way to center. Flesh pure white, firm, rather brittle, mild, not turning brown when bruised, about 8-9 mm. thick at stem.

Gills moderately close, about 5-6 mm. wide near the center, pointed at each end, nearly all of the same length, a few forked near the stem, lightly veined at cap, whitish, then pallid fleshy-cream, slowly changing to light smoky brown when rubbed.

Stem about 4.5-5.5 cm. long and 1.9-2.3 cm. thick, pure white, glabrous, stuffed.

Spores creamy yellow, subspherical, minutely tuberculate-roughened, 6.6-9.2μ.

2129. Mixed woods near the barn, Glenn Burnie Farm, June 17, 1916.

41. **Russula graminicolor** Quél.

Cap 5-10 cm. broad, convex then plane, or depressed, quite viscid when wet, green, shaded with brown, especially at the center, margin thin, becoming striate; taste mild.

Gills pale cream color, darker with age, adnate, forking near the stem.

Stem white, firm, equal, glabrous.

Spores pale yellow, broadly ellipsoid, 7-9μ long, spinulose.

My plants closely resemble Rickens' figure. The spores are different from those of *R. olivascens*. It is rare at Asheville apparently, having been found only once.

42. **Russula subvelutina** Pk.

PLATE 104.

Cap 5-10 cm. broad, convex then depressed, varying in color from a pink-red (Eugenia red—Ridgway) to pink or almost flesh color, dry, minutely pubescent, margin even, sometimes slightly striate with age; taste mild.

Gills white then cream color, often forked, adnate.

Stem usually colored like the cap, but paler, spongy within, becoming hollow.

Spores pale yellow (warm-buff—Ridgway), 7-9μ, subglobose, marked with warts and raised lines which are slightly connected in broken reticulations.

In pine woods, not rare. Asheville.

The cap of this species suggests *R. uncialis*, but the spores are distinctly different. The color of my plants is paler than the description would indicate, but it seems best to describe the form which occurs in our territory. It is a very pretty species.

Notes by Coker follow:

Cap about 2-3.8 cm. wide, regular or irregular, convex, or at maturity slightly depressed in center; surface minutely granular-tomentose, looking something like the surface of *Fistulina hepatica*, margin slightly striate; color an odd pinkish-red (exactly geranium pink or light coral-red of Ridgway), with yellowish spots, cuticle removable, noticeably sticky when bruised. Flesh thin, white, taste mild. There is a faint but distinct odor of peculiar character, resembling the smell in a laundry, it seems to me.

Gills all the same length, none or a few forked, rather close, light creamy yellow, connected by veins at the cap, their margins sometimes sticking together so tightly as not to be separated without breaking, adnate to stem, about 3-4 mm. deep.

Stem pure white or tinted with pink, 2.2-3 cm. long, 7-10 mm. thick at top, tapering downward, surface faintly scurfy-granular or appearing smooth, inside soft, cavernous.

Spores light creamy yellow, subspherical, rough, 5.4-7.5μ in diameter, no cystidia on gills.

This species is small in Chapel Hill. The color is decidedly a pink rather than red and is easily recognized. Miss Burlingham gives as a distinction between this and *R. Mariæ* that the context is not sticky when bruised; but in our plants the rubbed surface becomes decidedly sticky just as in *R. Mariæ*.

1648. One plant, in mixed woods southeast of Dr. Battle's, July 26, 1915.
1732. In sandy soil, woods near Battle's Branch, September 10, 1915.
2267. Mixed oak and pine woods, Lone Pine Hill, June 27, 1916. Spores elliptic, moderately roughened with low lines and warts, 4.8-7.4 x 7.4-10μ.
2304. Pine and oak woods, top of Lone Pine Hill, June 29, 1916.
2526. Mixed pine and oak woods southwest of athletic field, June 18, 1917.

Blowing Rock. Atkinson.

43. **Russula nauseosa** (Pers.) Fr.

PLATE 105.

This has been found only at Chapel Hill, and the following description is by Coker:

Cap about 5-7.5 cm. broad, depressed in center at maturity, irregular, margin striate for 0.5-1 cm.: surface quite viscid when wet, a dull deep purplish red in center, fading to dull brownish or buffy with a slight vinaceous tint. Flesh about 5 mm. thick at stem, pallid white, mild but faintly disagreeable, not very brittle.

Gills 5-8 mm. wide, crowded at stem subdistant at margin, all of equal length and none forked, just reaching stem, pallid when young, dull cream color at full maturity.

Stem 3-4.5 cm. long, 12-18 mm. thick, nearly equal, glabrous, white all over, stuffed, not hollowed.

Spores pale orange yellow of Ridgway, subspherical, echinulate, 5.9-8μ.

2122. Oak grove south of President's house, June 16, 1916. Photo.

We have also found in Chapel Hill a plant that varies somewhat from the above and seems to agree with *R. Turci* Bres., which Maire thinks is the same as *R. nauseosa*. I describe it as follows:

Cap viscid, shining depressed, margin tuberculate-striate. Odor distinct, sweetish, not unpleasant, not at all like that of *R. xerampelina;* color an odd purplish-brown which was much deeper in a zone halfway to margin.

Gills pale tan on side view, between buff-yellow and maize yellow (Ridgway) on edge view, smoky on drying.

Stem white, turning slowly smoky when rubbed, *not* yellow.

Spores buff-yellow, short-elliptic to subglobose, marked with lines which are more or less reticulating, 7-9μ.

2441. Mixed woods near creek below Lone Pine Hill, September 18, 1916.

44. **Russula Romellii** Maire.

PLATE 106.

Cap 5-10 cm. broad, convex, becoming depressed, dry, pruinose, dark red or purple red, even on the margin; flesh white, red under the cuticle.

Gills subdistant, yellowish, becoming deep yellow.

Stem equal, colored like the cap, but lighter, firm.

Spores deep yellow (ochraceous buff—Pk.), 8-9μ, marked with raised reticulating lines.

In woods, common. Asheville.

This species, if it is well founded, scarcely differs from *R. alutacea* except in the character of the spore surface.

45. **Russula alutacea** Fr.

PLATES 107 AND 111.

Cap fleshy, large and firm, 6-12 cm. broad, viscid when moist, red, or purple red, sometimes with olive or green tints, even at first on the margin, then striate or tuberculate-striate; taste mild.

Gills broad, thick, pale yellow at first, then ochraceous, rounded and nearly free behind.

Stem solid, white or colored like the cap.

Spores ochraceous, broadly ellipsoid, 9-11μ long, spinulose.

This is a fine, robust species, but it is not common near Asheville. The deep yellow spores and mild taste will help in its recognition, though it appears in many disguises.

Notes by Coker follow:

Cap to 12.5 cm. in diameter, conspicuous on account of its bright deep-red color, which often fades into pallid reds in spots and in age usually assumes a purplish-red tint (almost rosolane purple Ridgway); surface smooth and viscid, with striate margin usually, but in fresh specimens the striæ are often scarcely noticeable. Flesh very soft, white or rosy. Spores between maize yellow and buff yellow (Ridgway), slightly lighter than those of *R. tenuipes*, spinulose, nearly spherical, about 6-10μ in diameter.

Common here in woods, groves, and grassy places, and easily distinguished by the red cap, distant and very deep-colored (antimony yellow) gills, deep-colored spores, and mild taste. Edible. It seems to me quite doubtful if *R. ochrophylla* Pk. is really distinct from this.

697. University campus, June 19, 1913. Abundant at this date.

868. Woods southeast of schoolhouse, October 2, 1913. Spores spherical, echinulate, one large oil drop, 6.5-8.3μ in diameter.

1107. Woods by branch above Meeting of the Waters, July 9, 1914. Photo. Spores about buff yellow, spherical, short-echinulate and with a conspicuous mucro, 7.4-9.2μ.
1364. In new road to Piney Prospect, north of cemetery, October 16, 1914.
1690. In Professor Howell's lawn under oak trees, September 6 and 7, 1915. Spores spherical to subspherical, echinulate, 5.8-7.2μ.
1734. In woods near Meeting of the Waters, September 10, 1915. Spores spherical, echinulate, one large oil drop, 6.5-10μ.
2081. In grass on campus, June 13, 1916.
2090. Dr. Lawson's lawn and in Battle's Park, in grass, June 14, 1916.
2184. Mrs. Kluttz's yard, June 20, 1916. Spores subspherical, moderately spinulose, 7.4-9.2μ.
2271. Woods at top of Lone Pine Hill, June 27, 1916.

46. **Russula aurantialutea** Kauffman.

PLATE 108.

Cap 2.5-5 cm. broad, soon depressed at the center, coppery orange with the center lighter and yellow to pale yellow, fading with age, viscid when moist, becoming striate on the margin with age, cuticle separable halfway to the center; taste slowly acrid.

Gills white, becoming pale yellow, attenuate toward the stem, a few shorter and forking.

Stem white, glabrous, soon hollow, slender.

Spores yellow (about cadmium yellow of Ridgway), 7-9 x 7-8μ, strongly spinulose.

In oak woods, rather common. Asheville.

This is a pretty species and can be found all through the summer. As it occurs at Asheville, it is smaller than the type, which Kauffman finds up to 5 inches. Otherwise it answers well to the description.

46. **Russula tenuiceps** Kauffman.

PLATES 109 AND 111.

Cap 6-12 cm. broad, convex, soon expanded and depressed at the center, deep red, often with white or faded portions especially at the center, glabrous, viscid when moist, striate on the margin when mature, cuticle separable on the margin; taste acrid, odor in drying rather unpleasant.

Gills white, then pale yellow, becoming ochraceous in drying, equal, not forking, rounded behind.

Stem white, 6-12 cm. long, stuffed then hollow, becoming red when wounded, and slightly gray in drying.

Spores ochraceous, elliptic, 7-9μ long, marked with raised lines and warts.

This species is common in our woods. My specimens have been compared with some from Kauffman and seem to agree. It will be noted that one of the characters of my plant, the reddening of the stem, is not noted in the original description. In my region I find the stem always changing in the manner described, and find it a convenient mark of identification. The change in color is not rapid, but it is very marked. About two minutes are required for the change. It was thought at first that our plant must be distinct from Dr. Kauffman's species, but the agreement of the specimens with those from him makes it seem better to refer our plant to his species. It is quite possible that this character will be found in the Michigan plants.

Notes by Coker follow:

Cap about 9-11.5 cm. broad, depressed at the center, deep red with faded areas often, margin striate, cuticle removable on margin, glabrous, viscid when wet, often white-dotted from the gnawing of snails; thick near center, pure white, quite fragile and brittle, acrid, odorless.

Gills scarcely crowded, nearly all the same length, few or none forked, about 1 cm. broad, veined at cap, nearly white, then rather light ochraceous.

Stem about 5-8.5 cm. long and about 2 cm. thick, nearly equal, or variously irregular, occasionally swollen to about 2.8 cm. thick, except at top; surface glabrous, rivulose, pure white all over, slightly stuffed, then cavernous.

Spores between buff-yellow and antimony yellow of Ridgway, subspherical, marked with short spines and broken ridges, 6.6-9.6μ.

Common in summer in groves and woods.

2126. On campus near Confederate Monument, June 16, 1916. Photo.
2127. Mixed woods at top of Lone Pine Hill, June 17, 1916.

47. **Russula pungens** n. sp.

PLATES 110 AND 111.

Cap 6-12 cm. broad, peach red to opal red, with areas which are paler or even nearly white, firm, slightly viscid when young, even or slightly striate on the margin with age, minutely velvety. Flesh white, red under the cuticle, which is separable on the margin only; taste quickly and intensely acrid.

Gills white at first, cream color, in old specimens, rather crowded, 7-10 mm. broad at the center, rounded at the stem, many forking at the stem, a few forking elsewhere and shorter.

Stem firm, 7-10 cm. long, 1.5-2.5 cm. thick, white, spongy stuffed.

Spores subglobose, to broadly elliptic, 7.5-9μ long, marked with spines and short ridges. Margins and sides of gills thickly set with prominent projecting cystidia; color in mass close to Ridgway's pale orange-yellow.

This is one of our largest and finest species. It was collected in quantity the past season and carefully studied. It is distinctly different from *R. tenuiceps*. The spores are very different in color, being distinctly lighter. Fine spore prints were found to be much darker than *R. sanguina* and lighter than *R. alutacea* and *R. tenuiceps*. They are very close to the spore color of *R. atropurpurea* Pk. The intensely acrid taste seems its most striking character. It is easily the most acrid species found in the region around Asheville. If incautiously tasted the effect is positively painful, more so than in the case of *R. fragilis*, *R. sanguinea*, or *R. albidula*, which are probably three of our most acrid species.

In many ways this species seems to resemble *R. badia* Quél, but Miss Burlingham has compared my specimens with those of *R. badia* at New York, and finds them different. *Russula rubra* Kromb. as it is described and figured by Bresadola in Fungi Tridentini is also suggestive of our plant. The spore color, intensely acrid taste, and minutely velvety cap which Bresadola ascribes to it are all characteristic of our species. I have, however, seen no specimens of his plant, and should be reluctant to use his name in view of the uncertainty in regard to its correct application, even though our plants

should prove identical. Romell, who has seen our specimens, does not recognize them as occurring in Sweden. Our plant is certainly a fine and distinct species, and I have therefore somewhat reluctantly described it as new, though it may prove not to be unknown in Europe.

ASHEVILLE, N. C.

EXPLANATION OF PLATE 111

1. Russula nigricans.
2. Russula adusta (*R. densifolia* and *R. compacta* are much like this and the above species in spore characters).
3. Russula delica. According to Bresadola the spores of *R. delica* and *R. chloroides* are different, *R. delica* having the spore surface granulose and *R. chloroides* echinulate. At Asheville only specimens with echinulate spores are found. I have however referred them to *R. delica.*
4. Russula magna.
5. Russula xerampelina.
6. Russula uncialis.
7. Russula sanguinea.
8. Russula cinerascens.
9. Russula decolorans.
10. Russula variata.
11. Russula albida.
12. Russula alutacea.
13. Russula crustosa.
14. Russula fœtans.
15. Russula floccosa.
16. Russula lepida.
17. Russula olivascens.
18. Russula pusilla.
19. Russula pectinata.
20. Russula rubescens.
21. Russula Mariae.
22. Russula pungens.
23. Russula pulverulenta.
24. Russula albidula.
25. Russula meliolens.
26. Russula tenuiceps.
27. Russula flavida.
28. Russula aurata. Specimen from Maire (France).
29. Russula aurata. Specimens from Asheville.

PLATE 1.

AMANITA CHLORINOSMA. FORM A. NATURAL SIZE. No. 1253.

PLATE 2.

A B

A. AMANITOPSIS VAGINATA, TAWNY FORM, NATURAL SIZE. No. 2100.
B. AMANITOPSIS VAGINATA, WHITE FORM, NATURAL SIZE. No. 1843.

PLATE 3.

AMANITOPSIS VAGINATA, GRAY FORM, NATURAL SIZE. No. 2004.

PLATE 4.

AMANITOPSIS STRANGULATA. NATURAL SIZE. No. 2415.

PLATE 5.

AMANITOPSIS PARCIVOLVATA. NATURAL SIZE No. 2105

PLATE 6.

AMANITOPSIS AGGLUTINATA. NATURAL SIZE. Nos. 1601, 1602, 1603.

PLATE 7.

A

B

AMANITOPSIS FARINOSA. NATURAL SIZE. No. 1589 (A) and No. 2088 (B).

PLATE 8

AMANITOPSIS PUBESCENS. NATURAL SIZE. No. 767.

PLATE 9.

AMANITOPSIS PUBESCENS. NATURAL SIZE. No. 739.

PLATE 10.

AMANITA CÆSARIA, ABOUT TWO-THIRDS NATURAL SIZE. No. 505.

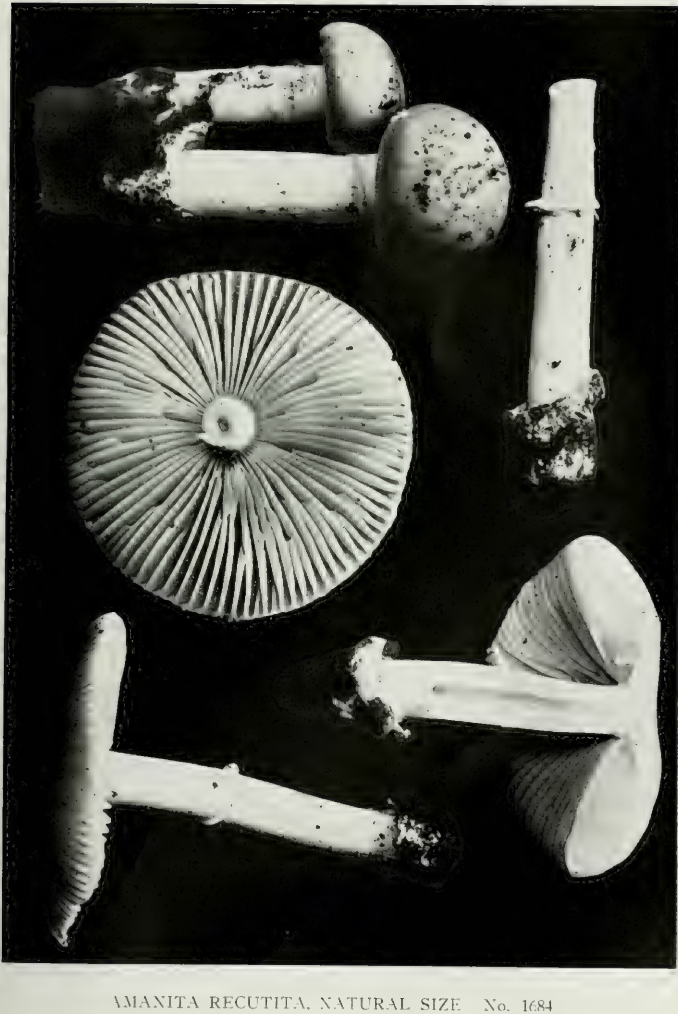
PLATE 11.

AMANITA CÆSARIA, NATURAL SIZE. No. 520.

PLATE 12.

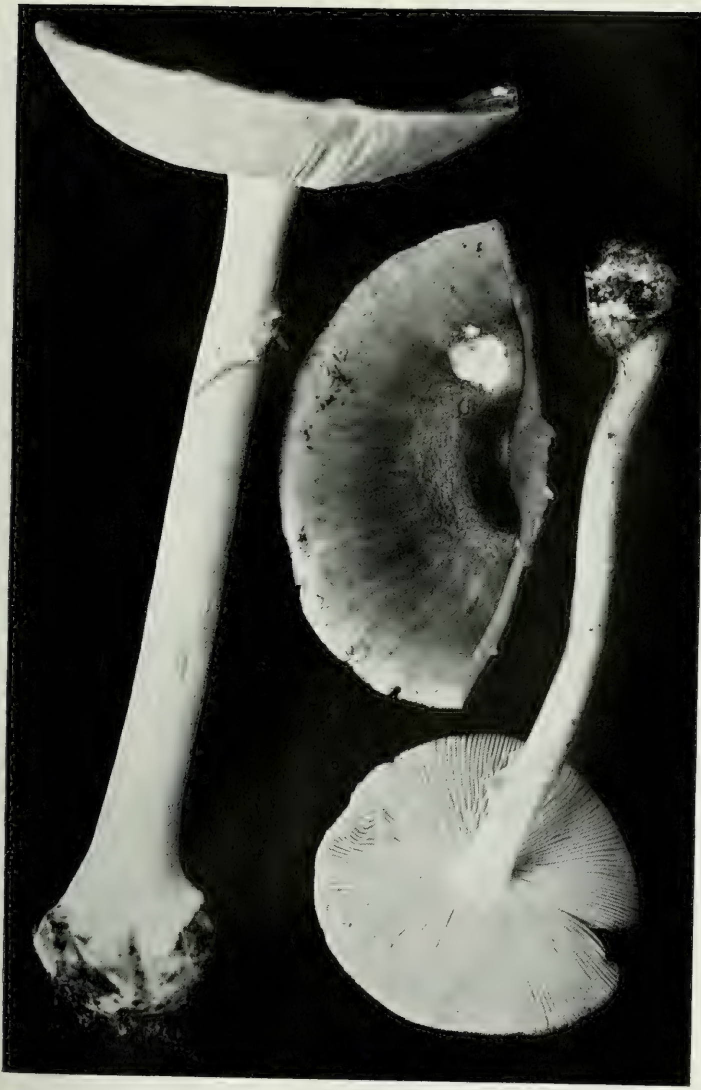
AMANITA SPRETA, FOUR-FIFTHS NATURAL SIZE. No. 487.

PLATE 13.



AMANITA RECUTITA, NATURAL SIZE No. 1684

PLATE 14.



AMANITA PHALLOIDES, REDUCED ABOUT ONE-EIGHTH. No. 796.

PLATE 15.

AMANITA VERNA, TYPICAL FORM, NATURAL SIZE. No. 454.

PLATE 16.

AMANITA VERNA, FORM WITH TWO SPORES, NATURAL SIZE. No. 2271.
(A. BISPORIGERA ATK.)

PLATE 17.

AMANITA HYGROSCOPICA, NATURAL SIZE. No. 2275.

PLATE 18.

AMANITA HYGROSCOPICA, NATURAL SIZE. No. 2261.

PLATE 19.

AMANITA MAGNIVELARIS, NATURAL SIZE. No. 452.

PLATE 20.

AMANITA MAGNIVELARIS. NATURAL SIZE. No. 452.

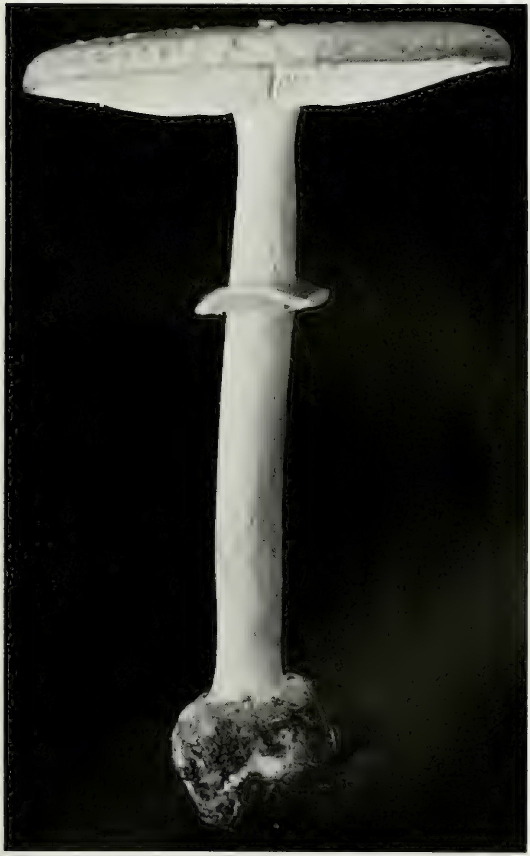
PLATE 21.

AMANITA MAGNIVELARIS. NATURAL SIZE. No. 533.

PLATE 22.

AMANITA MAPPA VAR. LAVENDULA, NATURAL SIZE. No. 590.

PLATE 23.



AMANITA MAPPA VAR. LAVENDULA, NATURAL SIZE. No. 1432.

PLATE 24.

AMANITA GEMMATA, FOUR WITHOUT VEIL AND FOUR WITH VEIL. NATURAL SIZE

PLATE 25.

AMANITA COTHURNATA. WHITE FORM, NATURAL SIZE. No. 1123.

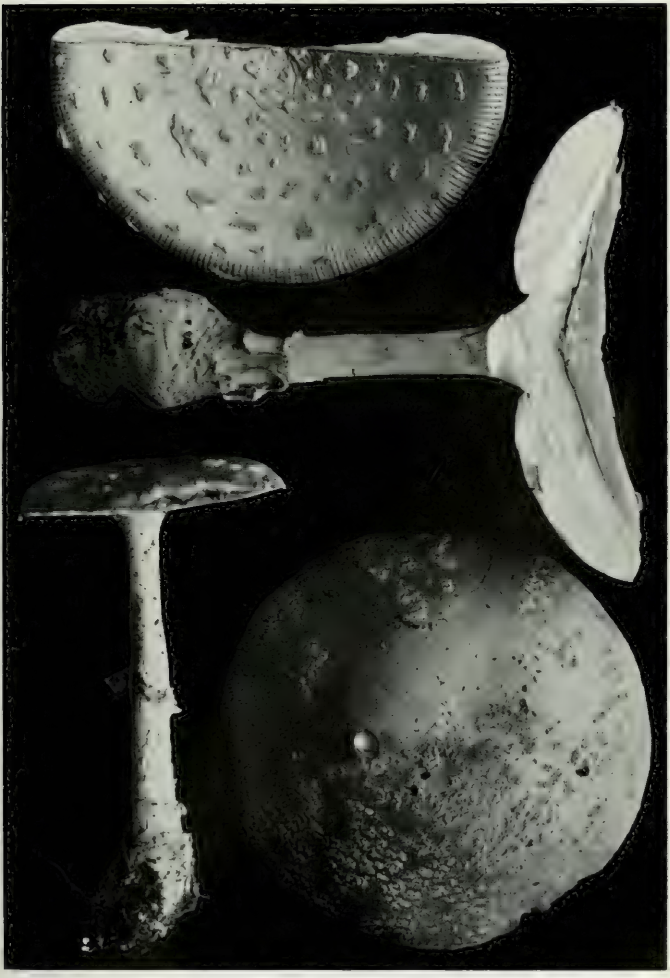
PLATE 26.

AMANITA COTHURNATA, NATURAL SIZE. No. 1725.

PLATE 27.

AMANITA MUSCARIA, NATURAL SIZE. No. 1953.

PLATE 28.



AMANITA MUSCARIA. SMALL SALMON FORM. NATURAL SIZE. No. 880

PLATE 29.

AMANITA MUSCARIA, DEPAUPERATE FORM WITHOUT VEIL, NATURAL SIZE. No. 1749.

PLATE 30.

AMANITA SPISSA, NATURAL SIZE. No. 2194.

PLATE 31.

AMANITA SPISSA. NATURAL SIZE. (A. SUBMACULATA PK.) No. 2206

PLATE 32.

AMANITA EXCELSA, NATURAL SIZE. No. 736.

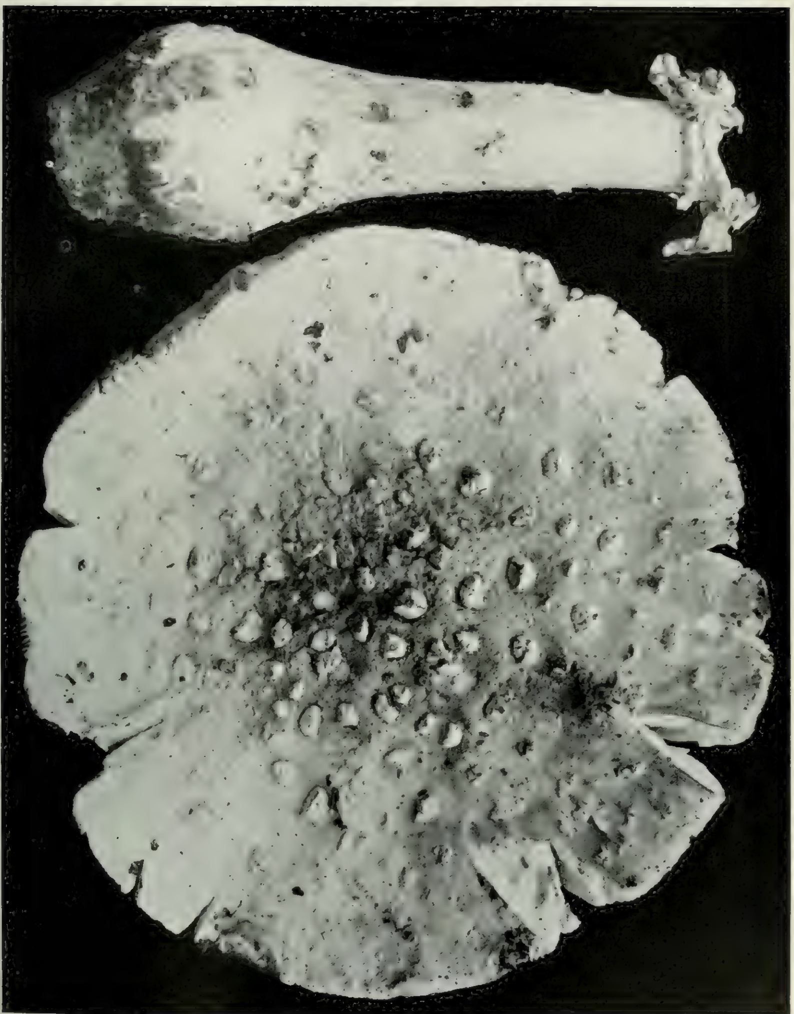
PLATE 33.

AMANITA EXCELSA, NATURAL SIZE. No. 521.

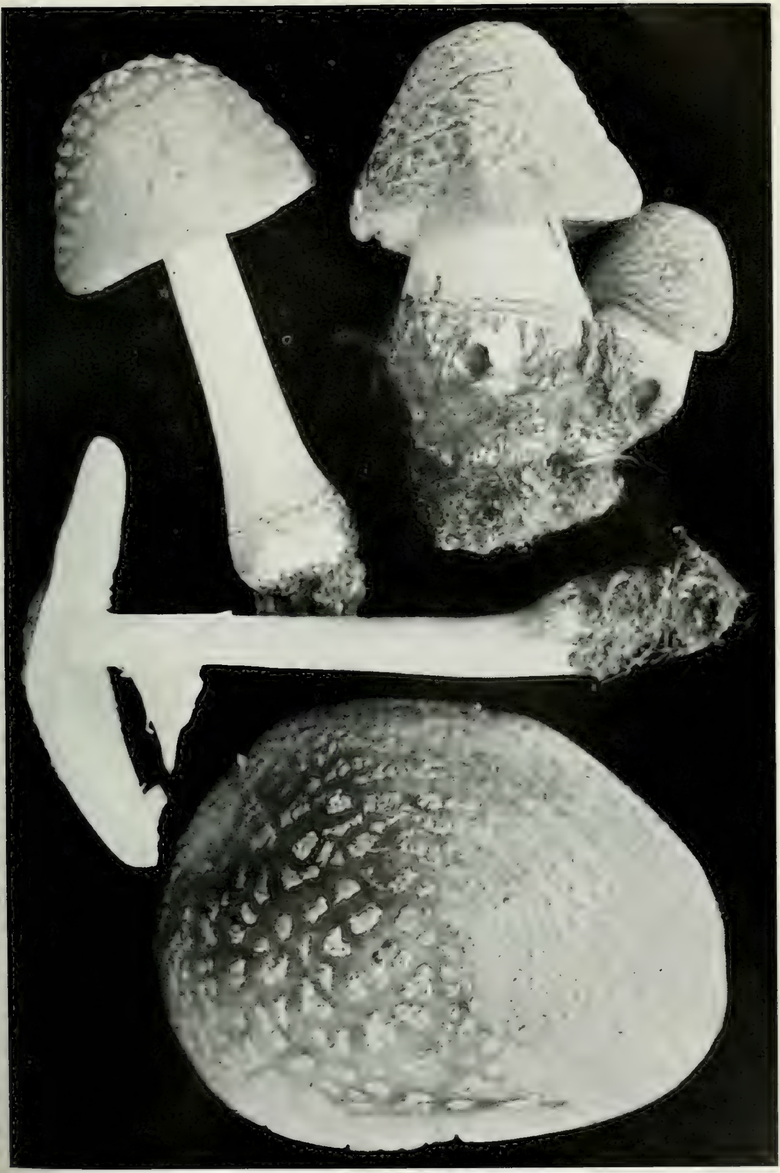
PLATE 34.

AMANITA EXCELSA. NATURAL SIZE. No. 1141.

PLATE 35.



AMANITA EXCELSA, NATURAL SIZE. No. 794



AMANITA RUBESCENS, NATURAL SIZE. No. 1135.

PLATE 37.

AMANITA RUBESCENS, SLIGHTLY REDUCED. No. 1828.

PLATE 38.

AMANITA RUBESCENS. DEPAUPERATE FORM. NATURAL SIZE. No. 571.

PLATE 39.

AMANITA FLAVORUBESCENS, NATURAL SIZE. No. 1158

PLATE 40.

AMANITA FLAVORUBESCENS. NATURAL SIZE. No. 1158.

PLATE 41.

AMANITA FLAVORUBESCENS. A FORM. NATURAL SIZE. No. 2133.

PLATE 42.

AMANITA FLAVORUBESCENS. A FORM. NATURAL SIZE. No. 2133.

PLATE 43.

AMANITA FROSTIANA. NATURAL SIZE. No. 1112.

PLATE 44.

A

B

AMANITA FROSTIANA, NATURAL SIZE, No. 758 (A) and No. 1822 (B).

PLATE 45.

AMANITA SOLITARIA, NATURAL SIZE. No. 450.

PLATE 46.

AMANITA SOLITARIA, NATURAL SIZE. No. 814

PLATE 47.

AMANITA SOLITARIA, REDUCED. No. 475.

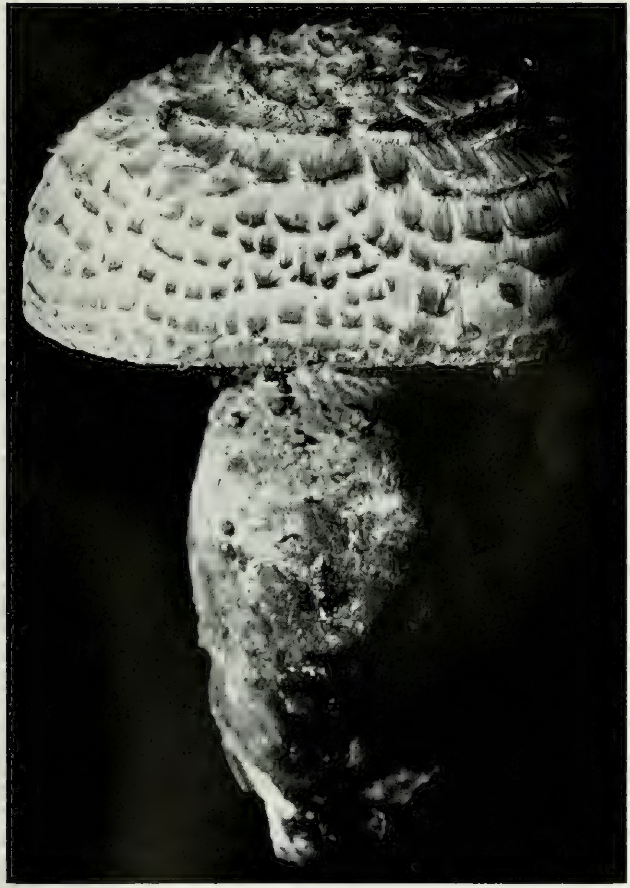
PLATE 48.

AMANITA ABRUPTA, NATURAL SIZE. No. 760.

PLATE 49.

AMANITA ABRUPTA, NATURAL SIZE. No. 760.

PLATE 50.



AMANITA STROBILIFORMIS. NATURAL SIZE. No. 856.

PLATE 51.

AMANITA STROBILIFORMIS. NATURAL SIZE No. 849

PLATE 52.

AMANITA STROBILIFORMIS. REDUCED (ACTUAL LENGTH, 20 CM.).
No. 855.

PLATE 53.

AMANITA STROBILIFORMIS. REDUCED (ACTUAL LENGTH, 21.3 CM.).
No. 911.

PLATE 54.

AMANITA CHLORINOSMA, TYPICAL. REDUCED. No. 540

PLATE 55.

AMANITA CHLORINOSMA, TYPICAL. NATURAL SIZE. No. 431

PLATE 56.

AMANITA CHLORINOSMA, REDUCED. No. 435.

PLATE 57.

AMANITA CHLORINOSMA, FORM A, NATURAL SIZE. No. 858.

PLATE 58.

AMANITA ATKINSONIANA, NATURAL SIZE. No. 870.

PLATE 59.

AMANITA ATKINSONIANA. NATURAL SIZE. No 870

PLATE 60.

AMANITA CINERECONIA, NATURAL SIZE. No. 2391.

PLATE 61.

AMANITA CINERECONIA, NATURAL SIZE. No. 2391.

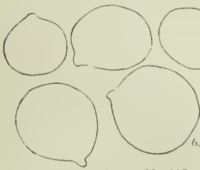
PLATE 62.

6.5-9 µ.

Amanitopsis vaginata. No. 414
Tawny form

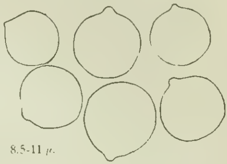
7.5-9.4 µ.

Amanitopsis vaginata. No. 1101
Tawny form



6.6-14.8 µ

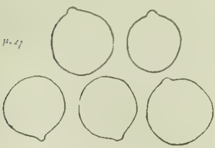
Amanitopsis vaginata. No. 807
Tawny form



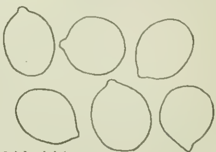
8.5-11 µ.

Amanitopsis vaginata. No 1843
White form

8-11 µ.



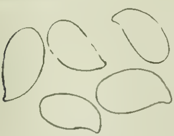
Amanitopsis strangulata. No. 2196



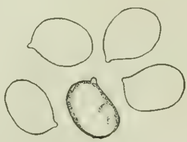
7.5-9.3 x 9.4-11 µ.

Amanitopsis strangulata No. 2201

4.4-5.5 x 7.5-11 µ



Amanitopsis agglutinata. No. 1576



6.2-7.4 x 9.7-10.5 µ.

Amanitopsis parcivolvata No. 801

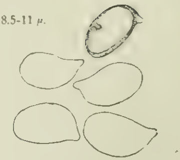
All the spore drawings on this and the following plates are magnified by 1080

PLATE 63.

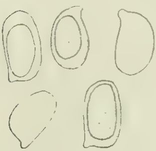
4.4-6.3 μ

Amanitopsis farinosa. No. 2136

5.5-6.6 x 8.5-11 μ.

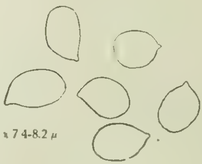


Amanitopsis pubescens. No. 739



5.2-7.4 x 8.5-11.5 μ.

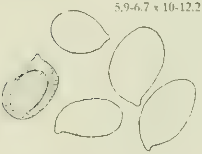
Amanita recutita No 1684



5.1-6.3 x 7.4-8.2 μ

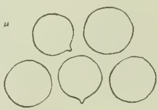
Amanita caesaria No 450*a*

5.9-6.7 x 10-12.2 μ.

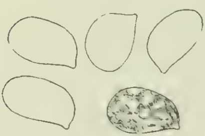


Amanita spreta. No. 487

6.6-8.2 μ

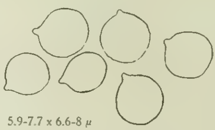


Amanita porphyria. Sweden



6.7-8.2 x 10-12.6 μ.

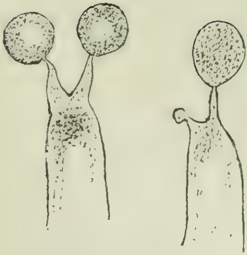
Amanita spreta var. parva No. 1624



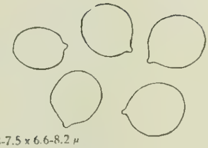
5.9-7.7 x 6.6-8 μ

Amanita phalloides. No. 796

PLATE 64.



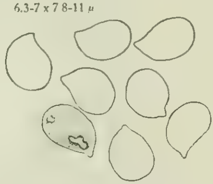
Amanita verna. No. 1645
Two-spored form



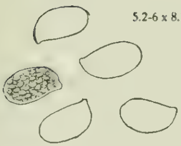
5.8-7.5 x 6.6-8.2 μ

Amanita verna No. 749

6.3-7 x 7 8-11 μ

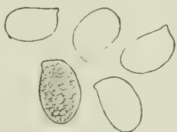


Amanita verna. No 707



5.2-6 x 8.1-10 μ.

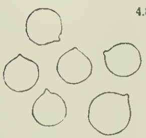
A. magnivelaris. Type



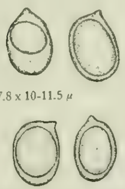
5.9-6.6 x 9.7-10.8 μ

Amanita magnivelaris No. 160

4.8-6.3 μ.



Amanita mappa var. lavendula. No. 1432

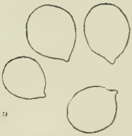


6.6-7.8 x 10-11.5 μ

Amanita hygroscopica. No. 2261

PLATE 65.

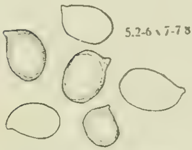
6.1-7 x 6.7-7.8 μ



Amanita gemmata
(Amanitopsis albocreata. Type)

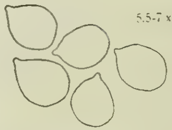
Amanita gemmata
(A. velatipes. Type)

5.2-6 x 7-7.8 μ



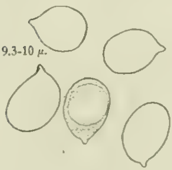
Amanita gemmata. No. 2054

5.5-7 x 7-9.3 μ.



Amanita gemmata. No. 419
Form without veil

6.6-7.5 x 9.3-10 μ.

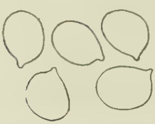


Amanita cothurnata
Blowing rock

6.6-6.7 x 7-7.8 μ

Amanita gemmata
(A crenulata Type)

6.3-7 x 7.5-8.1 μ.



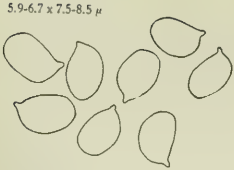
Amanita muscaria. No. 880
Small salmon form

6.3-8.1 x 7.4-10 μ

Amanita muscaria. No. 1911
Large form

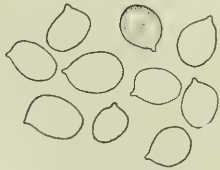
PLATE 66.

5.9-6.7 x 7.5-8.5 μ



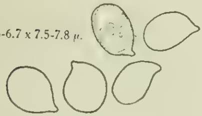
Amanita spissa (A. Morrisii, Type)

4.5-6 x 6.5-8.5 μ.

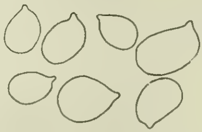


Amanita spissa. No 2178
(A. Morrisii)

6-6.7 x 7.5-7.8 μ.



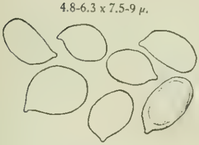
Amanita spissa. Sweden



4.8-6.7 x 6.5-9.4 μ.

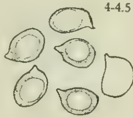
Amanita spissa. No. 842

4.8-6.3 x 7.5-9 μ.

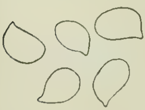


Amanita spissa. No. 2206
(A. submaculata)

4-4.5 x 6.5-7 μ.



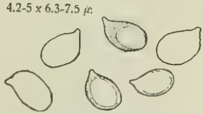
Amanita spissa. No. 2215



4-5.2 x 6.6-8.1 μ.

Amanita spissa. No. 2194

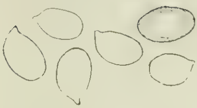
4.2-5 x 6.3-7.5 μ.



Amanita spissa var. alba
Hartsville, S. C. No. 11

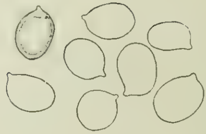
PLATE 67.

4.8-6 x 6.6-8 5 μ.



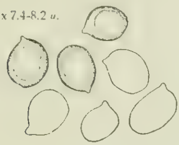
Amanita excelsa. No. 514

5.5-6.7 x 7.4-9 μ



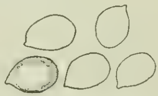
Amanita rubescens. No 513

5-6.6 x 7.4-8.2 μ.



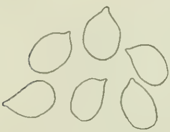
Amanita rubescens. No. 1828

4.5-5.5 x 7.4-8.2 μ.



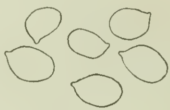
Amanita rubescens. No 751
Depauperate form

4.5-5.5 x 7-8 μ.



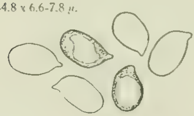
Amanita rubescens var. alba. No. 2346

4.5-5.2 x 6-7 5 μ.

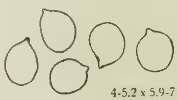


Amanita rubescens var. alba No. 2355

4.4-4.8 x 6.6-7.8 μ.



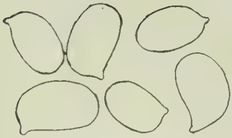
Amanita flavorubescens. No. 1158



4-5.2 x 5.9-7 5 μ.

Amanita Frostiana. No. 1112

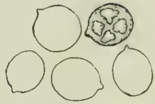
PLATE 68.



6.6-7.7 x 11-13.7 μ.

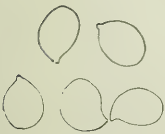
Amanita solitaria. No. 814

5.9-7.4 x 6.6-9 μ



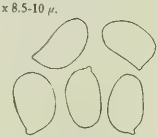
Amanita abrupta. No. 760

5.5-6.7 x 7.5-8.2 μ.



Amanita strobiliformis. No. 849

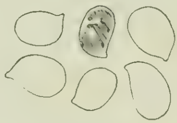
4.8-6.3 x 8.5-10 μ.



Amanita chlorinosma. No. 431
Large white form

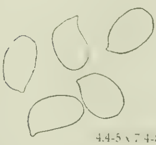
4.8-7.4 x 9-11 μ.

Amanita chlorinosma. No 351
Green form



5.2-8 x 7.7-10.8 μ.

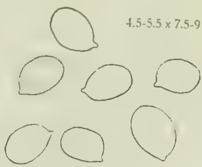
Amanita Atkinsoniana. No. 824



4.4-5 x 7.4-8.5 μ

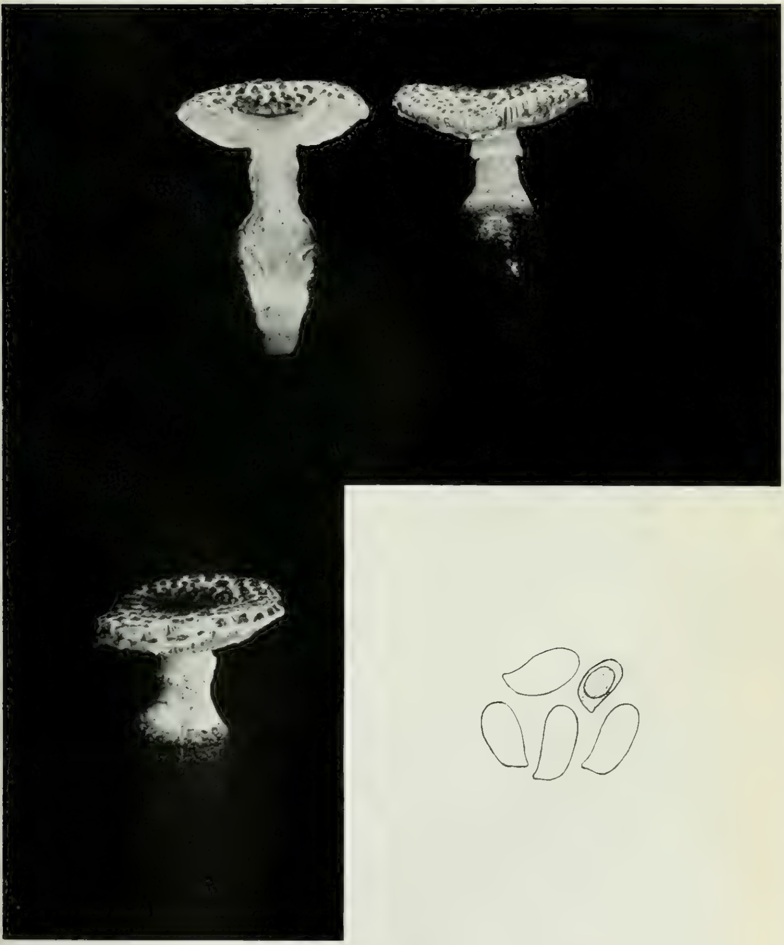
Amanita cinereconia. No. 2391

4.5-5.5 x 7.5-9 μ.



Amanita virosa
Hartsville, S. C. No. 10

PLATE 69.



AMANITA NITIDA, NATURAL SIZE. No. 2525.
SPORES MAGNIFIED BY 1080.

PLATE 70

RUSSULA DELICA. NATURAL SIZE. No. 2188

Photo by W. C. C.

PLATE 71

RUSSULA DELICA. NATURAL SIZE

Photo by H. C. B.

PLATE 72

RUSSULA VARIATA, NATURAL SIZE

Photo by H. C. B.

PLATE 73

RUSSULA ADUSTA. NATURAL SIZE

Photo by H. C. B.

PLATE 74

RUSSULA COMPACTA. NATURAL SIZE. No. 2319

Photo by W. C. C.

PLATE 75

RUSSULA EARLEI. NATURAL SIZE. No. 2292

Photo by W. C. C.

PLATE 76

RUSSULA NIGRICANS, NATURAL SIZE. No. 1151 AND No. 1152 *Photo by W. C. C*

PLATE 77

RUSSULA EMETICA. NATURAL SIZE. No. 1110

Photo by W. C. C.

PLATE 78

RUSSULA CINERASCENS, NATURAL SIZE

Photo by H. C. B.

PLATE 79

RUSSULA ALBIDA, NATURAL SIZE *Photo by H. C. B.*

PLATE 80

RUSSULA ALBIDA. NATURAL SIZE. HARTSVILLE, S. C. No. 27 *Photo by W. C. C.*

PLATE 81

RUSSULA FLAVA, NATURAL SIZE. No. 2532 *Photo by W. C. C.*

PLATE 82

RUSSULA FLAVIDA, NATURAL SIZE. No. 494

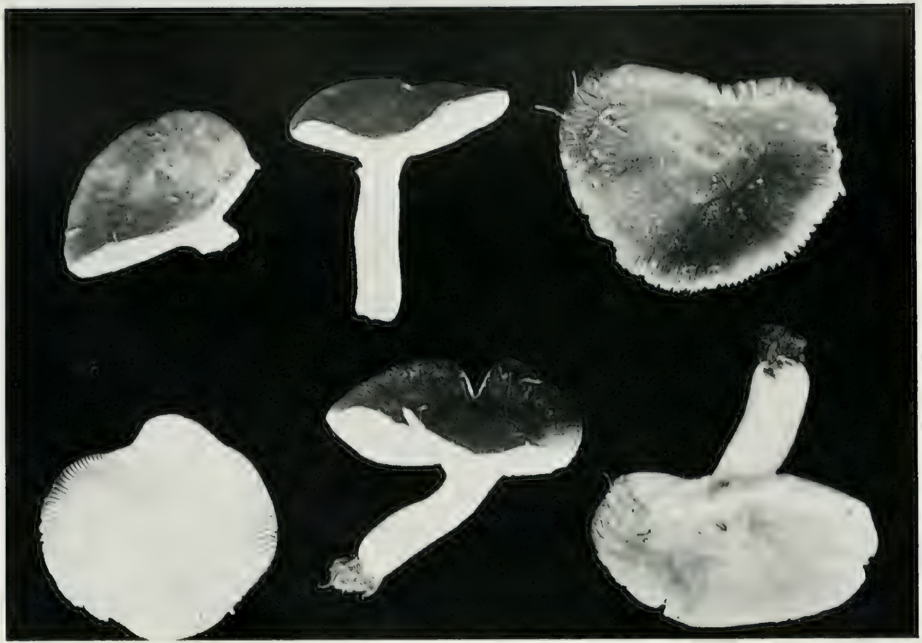
Photo by W. C. C.

PLATE 83

RUSSULA DECOLORANS, NATURAL SIZE

Photo by H. C. B.

PLATE 84



RUSSULA PUSILLA, NATURAL SIZE. No. 1090

Photo by W. C. C.

PLATE 85

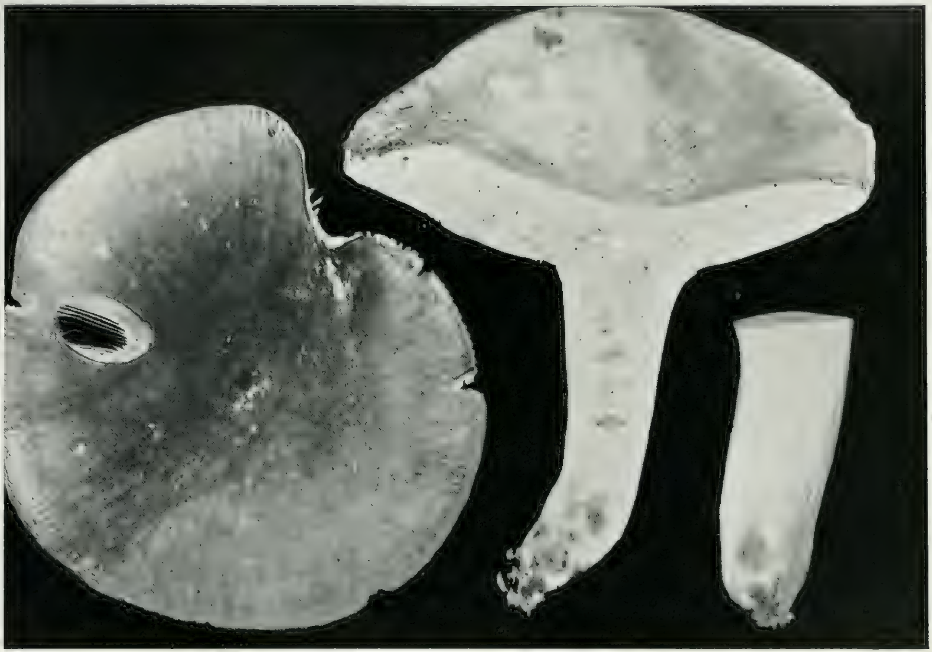
RUSSULA MELIOLENS, NATURAL SIZE

Photo by H. C. B.

PLATE 86

RUSSULA MARIAE. NATURAL SIZE. No. 2187

PLATE 87



RUSSULA CYANOXANTHA. NATURAL SIZE. No. 864 *Photo by W. C. C.*

PLATE 88

RUSSULA CRUSTOSA, NATURAL SIZE

Photo by H. C. B.

PLATE 89

RUSSULA ALBIDULA, NATURAL SIZE

Photo by H. C. B.

PLATE 90

RUSSULA SANGUINEA, NATURAL SIZE

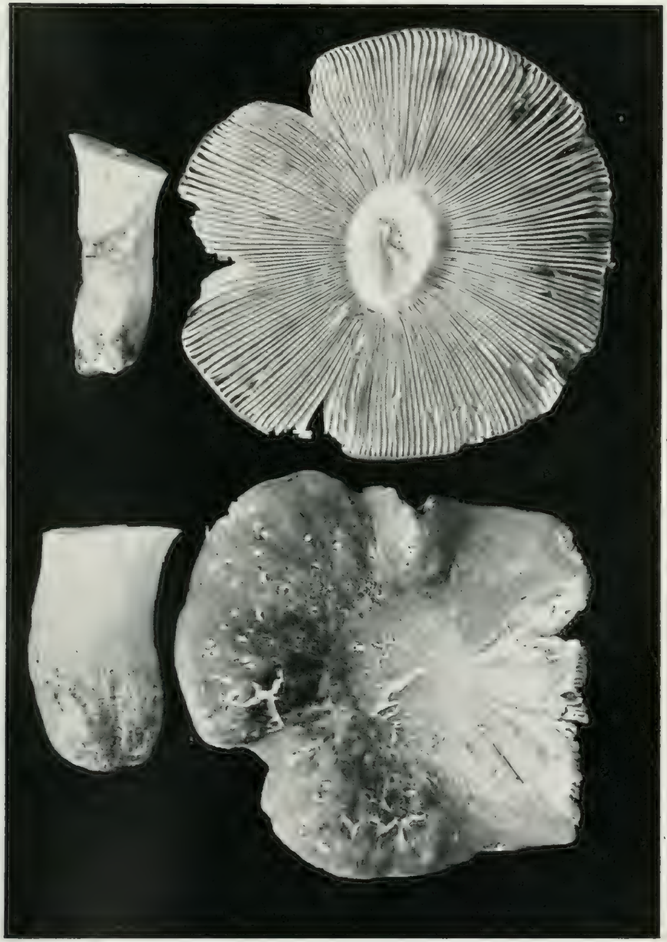
Photo by H. C. B.

PLATE 91

RUSSULA LEPIDA, NATURAL SIZE

Photo by H. C. B.

PLATE 92



RUSSULA LEPIDA. ABOUT 2/3 NATURAL SIZE. No. 2258

Photo by W. C. C.

PLATE 93

RUSSULA FOETANS. NATURAL SIZE. No. 1636

Photo by W. C. C.

PLATE 94

RUSSULA PECTINATA, NATURAL SIZE

Photo by H. C. B.

PLATE 95

RUSSULA PULVERULENTA, NATURAL SIZE
Photo by H. C. B.

PLATE 96

RUSSULA LUTEOBASIS. NATURAL SIZE. No. 2252

Photo by W. C. C.

PLATE 97

RUSSULA RUBESCENS, NATURAL SIZE

Photo by H. C. B.

PLATE 98

RUSSULA MAGNA, NATURAL SIZE

Photo by H. C. B.

PLATE 99

RUSSULA MAGNA. NATURAL SIZE. No. 900 *Photo by W. C. C.*

PLATE 100

RUSSULA XERAMPELINA. NATURAL SIZE

Photo by H. C. B.

PLATE 101

RUSSULA AURATA, NATURAL SIZE

Photo by H. C. B.

PLATE 102

RUSSULA BASIFURCATA. NATURAL SIZE

Photo by H. C. B.

PLATE 103

RUSSULA GRISEA, NATURAL SIZE. No. 2564

Photo by W. C. C.

PLATE 104

RUSSULA SUBVELUTINA, NATURAL SIZE

Photo by H. O. B

PLATE 105

RUSSULA NAUSEOSA, NATURAL SIZE. No. 2122

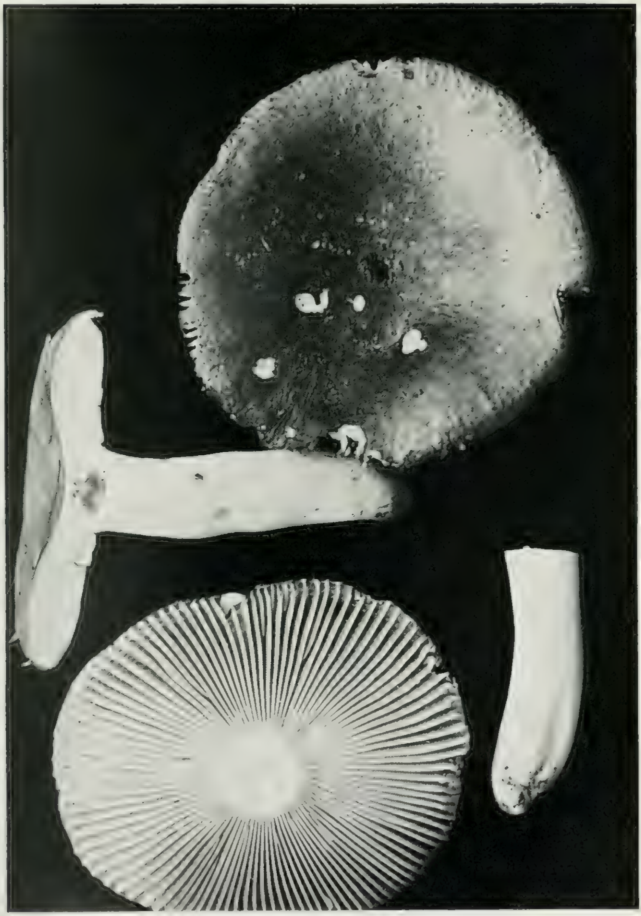
Photo by W. C. C

PLATE 106

RUSSULA ROMELLII, NATURAL SIZE

Photo by H. C. B.

PLATE 107



RUSSULA ALUTACEA. NATURAL SIZE. No. 1107

Photo by W. C. C.

PLATE 108

RUSSULA AURANTIALUTEA, NATURAL SIZE *Photo by H. C. B*

PLATE 109

RUSSULA TENUICEPS, NATURAL SIZE

Photo by H. C. B.

PLATE 110

RUSSULA PUNGENS, NATURAL SIZE

Photo by H. C. B.

PLATE 111